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ABSTRACT

A study was undertaken to apply family investment techniques and public expenditure analysis to problems faced in higher education, treating expenditures for higher education as an investment in human resources. The report is addressed to economists, policy makers, and educators and students, and is both technical and nontechnical in its various parts. It covers personal (family), state, and federal investment in higher education in theory and practice, and investment in research at higher education institutions. (MSE)

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Final Report

SOURCES OF FLUCTUATIONS AND GROWTH OF INVESTMENT IN HIGHER EDUCATION

Walter W. McMahon

University of Illinois
Urbana, Illinois
December 1972

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Conclusions and points of view expressed herein are in no way to be interpreted as representing policies of either the Spencer Foundation or the Office of Education, but are the sole responsibility of the author.

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Preface

This volume originates from the decision to apply past experience with the analysis of family investment decisions and the analysis of public expenditure to some of the main problems currently being faced in higher education. "Education" and "health" have become much more tractable for the economist in recent years because of breakthroughs in development of the concept of expenditures on them as investment in human resources. At the same time education is important to the nation's well being, accounting with related human resources for more of the differences in per capita income between the United States and the less developed countries than all of the other factors combined.[1] Higher education is also potentially a significant force weighing heavily against the inequality produced by inheritance and vested interests and for greater equality of opportunity in coming generations. With concepts of this significance, it is surprising that current expenditures on higher education have not been studied theoretically and empirically as an important form of investment behavior over time. That is the purpose of this study.

This book is addressed to three types of readers. It is addressed to economists, some of whom have been preoccupied with investment in physical capital and have not yet come to realize the full significance of investment in education (and health) Second, it is directed to policy makers, such as members of the National Commission on the Financing of Post-secondary Education, although it is hoped that they will not be put off by Chapter 2 but will skip the part of it from p. 7 onward and those parts of Chapter 3 that are technical. Third it is addressed to educators and students in economics and education. Background in regression analysis is assumed, but beyond this the few special economic terms used are likely to become familiar.

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[1] A. Krueger (1968).

This project has significantly benefited from the assistance and advice of many persons. I am especially grateful to H. T. James who was instrumental in joining with my interest in this area at an early date. T. W. Schultz, G. Judge, M. D. Orwig, and E. Denison have all had an important influence on the end result in various ways, although I would want to relieve all of them of any responsibility for the final product.

The primary support for the released time during the academic year that was instrumental in making this project possible was that provided by a grant from the U.S. Office of Education, Region V. I am especially grateful to Joseph A. Murnin, whose untimely death during the year saddened us all, and to Ellen Dye in that office.

I especially wish to express appreciation to the Spencer Foundation for the grant which made available the necessary computer time, the time for refinement of the basic model (Chapter 2), and the support for other research assistants who helped part of the time. Peter Moore helped with the research underlying Chapter 4, Virginia Klarquist with Chapter 3, Alan Wagner with Chapter 2 and Table 4 in Chapter 6, and Jim Dyal with Appendix B in significant ways. During the summer of 1972 Willie Bailey and Bill Harris also gave useful assistance with parts of Chapter 5 and with the computer programming respectively. The U.S.O.E. grant supported Alicia Mullor for that summer while she helped as a research assistant in the preparation of Chapter 6 and Appendix C. A special personal debt of gratitude is due these graduate students, several of whom are now writing dissertations on related topics.

I would also like to express my appreciation to the University of Illinois for providing support for earlier work on primary and secondary education (McMahon (1970)), household saving and investment decisions (McMahon (1971)), and public expenditure theory (No. 1/1971). The Brookings Institution has generously aided me as a Guest Scholar in their Center for Advanced Study in the three final months during which the manuscript was completed. Mrs. Charlotte Kaiser at Brookings provided excellent assistance with the typing. And last but not least, I am especially grateful to my wife, Carolyn, for her counsel and support throughout.

Walter W. McMahon

Washington, D. C.
December, 1972

Investment in Higher Education

Walter W. McMahon

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Chapter 1

Introduction

The "new depression in higher education" described by a recent Carnegie Commission report[1] has serious implications for public and private higher education alike. This financing crisis facing institutions of higher education has been accompanied by several additional events that together have raised the financing of higher education to the front rank of national importance and created great interest in some fundamental questions in the subject of educational finance.

The second event responsible for the increasing importance and widespread interest is the passage of the "Education Amendments of 1972." The act contains some new departures that as they develop have extremely important and far reaching implications for the future of higher education. The third event broadening interest goes back to the rapid expansion of enrollments in the 1960's. More junior colleges were created, more state boards of higher education were set up for study of the subject, and more parents are feeling the issues of higher education finance directly through their pocketbooks than ever before in history. Fourth and last, there have been some breakthroughs in the discipline of economics relating to production of and investment in educational capital, as well as in relating its costs and benefits to economic growth and to equity. In part reflecting these events, a National Commission on the Financing of Higher Education was appointed by the President late in 1972 to study "the impact of past, present, and anticipated private, local, State, and Federal support for postsecondary education." Their study is broadly charged to include "the nature and causes of serious financial distress, .. the level of existing state and local, .. endowment, private sector, .. and Federal support" as a means of considering "alternative long range solutions."[2]

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[1] See Cheit (1971). This and all other references throughout by authors name and year refer to the list of References at the end of this study preceding the appendices.

But these four developments in the financing situation have contributed to a more permanent disequilibrium in the subject of educational finance that has even greater implications for the long run. Fundamental questions are being raised in serious ways, in some cases for the first time, that have their immediately practical counterpart in day to day budget decisions and in publicized policy issues. First there are the newer human capital insights into the contribution of education, including higher education, to economic growth. Growth, labor, and international trade fields are being revolutionized by these contributions, while at the same time healthy doubts are raised by Jenks (1972) and others pointing to the role of "luck" as an important influence on earnings, doubts about just how much education really matters. Census data has permitted Denison (1973) to carefully estimate the contribution to economic growth of the earnings added by a college education, and much research is underway that in alternative ways attempts to correct for differences in ability, sex, race, "luck" and other such sources of differences in earnings (e.g., Griliches (1972), Hause (1972)). Concepts of investment in health capital (Grossman (1972)) and investment in educational capital (McMahon (see Chapter 2)), Michael (1972) also are developing rapidly. The literature furthermore is beginning to identify more adequately the social benefits (including externalities from research) and the non-monetary private satisfactions as a necessary preliminary step to improved measurement (e.g. Hartman (1972a), Mundel (1972), Bowen (1968) (1972), Western Interstate Commission on Higher Education (1970), Solomon (1972) Panel on the Benefits of Higher Education). It is ironical but also important that just as public and private education is undergoing the most serious depression in its entire history, these and other new insights in economics are making the various types of returns from education easier to recognize and somewhat easier to measure.

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[2] Education Amendments of 1972, Conference Report, HR 92-1085, 92d Congress, 2d Session, pp. 49-50, 185.

Fundamental questions are also being raised about the equity of the current investment in higher education with respect to its availability to the poor and the resulting effects on the next generation's distribution of income. There has been the nearly complete exclusion of the poor from institutions of higher learning, in part because achievement test scores reflect the pre-school and continuing production of educational capital in the household as well as the wealth of the primary and secondary school districts that low income parents are able to afford to live in. This is a point of strong interdependence between equity in higher education and the pressing problems of primary and secondary school finance.[3] Questions of vertical equity as between families (and students) at different levels in the income distribution go deeply into public expenditure theory (e.g. Musgrave (1969), McMahon (1971), Pechman (1972), and Hartman (1972b)). The public sector influences the breadth with which the benefits are distributed. Simon Kuznets (1955) a recent winner of the Nobel Prize in economics, also has identified tendencies toward greater equality in the income distribution, at least until recent years. He has attributed this in part to the reduction of the relative importance of income from property due to "greater investment in training and education" (Kuznets (1966), p. 218)). Equity is one very important theme in the Education Amendments of 1972.

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[3] For pioneering work on this subject see H. Thomas James, J. Thomas, and H. Dyck, Wealth, Expenditures, and Decision Making for Education, U.S.O.E. Project 1241 (Stanford, 1963). For an excellent and current treatment of the issues see Robert D. Reischauer and Robert W. Hartman, Reforming School Finance, The Brookings Institution, 1973.

Another fundamental development and one with important implications for stabilization policy is the recognition of the value of time in economics (e.g. Becker (1965) (1972)). It implies that students' foregone earnings are lowest when unemployment is high, creating unusually favorable opportunities for investment in human capital at those times, and costing the society less to get a given addition to potential future output.

It is these kinds of questions that are revolutionizing research in the field of educational finance, with outcomes that are likely to lead to continuing change and adjustment in higher education financing practices for some time to come.

The implications of the "new depression," widespread interest, concurrent fundamental questioning, and available new approaches dramatize the need for careful study of the major basic influences on investment in higher education and research. There is need to consider the short run volatility of investment-type decisions for example, so that whether the current situation is a short or longer run phenomenon can be kept in proper perspective.

Related to the possibly unique investment-in-knowledge orientation of this study is the need to bring the newer developments in economic theory to bear on investment behavior as a necessary complement to the numerous on-going studies of the returns to education. There is need to use this in structural models to improve upon the simple demographic extrapolations usually used in predictions. Finally, there is need to consider expenditures on higher education and research as investment-type expenditures that are important to the attainment of widely held stabilization, distribution, and growth objectives.

The sections that follow explain the steps to be taken in later chapters to implement this inter-temporal analysis of investment in human resources.

I. Investment Decisions by Households, by State and Local Governments, and by the Federal Government

Although several different types of decision units make investment decisions that result in expenditures on higher education and research, the investment process itself constitutes the unifying theme.

A specific theory of this investment process is set out in Chapter 2. In essence, investment in human capital occurs as families produce additions to their stock of human capital. They purchase formal education as a derived demand for an input which is combined with inputs of the student's own time to produce a stock of "educational capital" for use later. Demands for current, immediate, consumption satisfactions from college are included as part of the total demand for higher education but are not analyzed separately. A distinction is made between the short run, where all stocks are regarded as constant, and the longer run where stocks can grow, depreciate, and become obsolete with technical change and new knowledge. More generally, stocks of various kinds include the family's stock of educational capital, stocks of disembodied knowledge (e.g., libraries), and psychological stocks of tastes and habits as well as stocks of physical capital goods, and the term is used only to distinguish these from flows. The investment process is then extended to include investment in research leading to the creation of new ideas, adding to the stock of knowledge, and also yielding a flow into the future of monetary and non-monetary returns.

Families, state and local governments, and the Federal Government are basically different types of decision units. Their investment decisions therefore are considered separately using four structural models, each of which is drawn from its appropriate theoretical framework. They are:

Chapter 3 - Investment by Families in Higher Education,
Chapter 4 - State and Local Investment in Higher Education,
Chapter 5 - Federal Investment in Higher Education, and
Chapter 6 - Federal Investment in University-Based Research.

Family (i.e. household) investment at public and at private institutions is analyzed separately to permit estimation of the effect using time series data on relative changes in private and public tuition levels. The necessity for out-of-pocket expenditures by the family on tuition and fees and on room and board, combined with the possibility of short private investment horizons suggests that the family's budget constraint is relevant to these out-of-pocket outlays, especially early in the student's college career. So tuition and fees and room and board will be analyzed in two separate categories for public and private institutions, together with study of the household's total investment which includes foregone earnings in excess of room and board, an investment usually made primarily by the student.

Investment by state and local governments in higher education, considered in Chapter 4 leads to the production and supply of formal education by educational institutions, which is then made available to households at a subsidized price as an input for their use in producing educational capital. State expenditures on public and on private institutions are analyzed separately, corresponding to the breakdown used in Chapter 3. The support of problem-oriented research by states and localities (which is relatively small), as well as of graduate education, is impossible to analyze separately because adequate data are not yet available. However with some special work on the data, it has been possible to analyze separately state support for universities, four-year colleges, and two-year junior colleges in the entire post-war period. Gift and endowment fund income which is important to private institutions appears in the tables but is taken as exogenous and hence outside the scope of this study.

Federal investment in higher education, most of which goes to public institutions, is considered in Chapter 5, while federal investment in research, over 50 percent of which goes to private universities is considered in Chapter 6. Although federal support of higher education dates back to the Morrill Land Grant Act of 1862, it previously has not been possible to analyze federal support of research for any but the last few years. Therefore to permit separate analyses of education and research, for which the investment-demands respond to somewhat different factors, a new data series on federal investment in university-based research has been developed and is presented in Appendix C. Some additional work on the data has permitted not only the public-private institution breakdown extending back to 1929, but also the university, four year and two year institutions to be kept separate in the analysis throughout the entire post-war period.

II. Scope and Method of the Analysis

Apart from the basic theory of family investment decisions to be found in Chapter 2, a brief development of the relevant specific theoretical framework and brief references to the pertinent literature are to be found at the beginning of each chapter and are an important part of this study.

The scope of the empirical analysis is confined to use of time series data for the United States, 1929 to the present, for the categories of investment indicated above. So although the results do indicate which variables are most important overall, they do not extend to further tests of the hypotheses using microeconomic data. Such tests are underway, and although they will not be reported here in detail, the text throughout does reflect many microanalytic findings.

Data for the United States used in this study come primarily from the U.S. Office of Education Biennial Survey of Education, the Department of Commerce National Income and Product Accounts, and the Bureau of the Census Current Population Reports and technical papers.

Econometric estimating methods used in this study involve both single equation and simultaneous equation restricted three stage least square estimates which are obtained for each model. Since the objective is not to improve estimation theory, the basic reasons for using the latter are substantive economic ones. One of these (Appendix, Chapter 3) is to find tuition-price coefficients that are substantially free of simultaneous equation bias. The specification of a supply side which is required for the simultaneous estimates however depends upon a judgment as to whether it is best in this case to specify a supply-of-funds equation, or one dealing with the supply-price of the investment-good. This choice depends upon the theoretical context within which the rest of the model is specified (i.e., an internal rate of return or net present value formulation). The decision was made to use the latter, and hence the supply-price of formal education which makes more explicit the production costs within educational institutions. The choice was based in part on the form in which the data is available in this case, but also upon the gaps in the current state of knowledge about the length of the investment horizon and about non-monetary returns which are harder to accommodate in rate-of-return form, as are the absence of tendencies to a purely monetary full equilibrium.

In cases where the Durbin-Watson statistic is not within the acceptable range, a first order autoregressive transformation is applied that employs a Cochrane-Orcutt iterative technique to remove the autocorrelation from the residuals. Predictions are made using each investment model for the period to 1980. Some models are also estimated for the prewar 1929-41 period in order to check for any significant shifts by comparing these with the postwar 1946-68 period used where there are to be predictions.

This permits comparison of the actual to the predicted values for the first few years beyond the sample period. This is an important test of the hypotheses underlying the estimates of the structural parameters, as well providing some conditional forecasts up to 1980. The most important exogenous variables used in the predictions are income and prices, predictions for which have been made by the Eckstein-Fromm Data Resources econometric model used by the U.S. Office of Management and the Budget, and college-age population projections based on children now in elementary and secondary schools made by the Bureau of the Census.

III. Efficiency, Growth, and Equity

Some of the adjustments in higher educational finance that are currently underway in response to the efficiency and equity "disequilibria" are clearly beyond the scope of this study. Cost effectiveness analysis, for example, is being introduced in many institutions. New forms of cooperation among institutions are beginning to arrive at common definitions of costs and to identify benefits to improve the bases for cost benefit analysis. Manpower studies, to cite another example, have identified the overinvestment in some fields relative to the investment in others leading to cutbacks in the training of teachers and physicists where job markets have been weak, and to increased training of doctors, a field in which there continues to be critical shortages. New concern with pollution and other externalities also has led to expanded research and new courses dealing with the problems of the environment. And finally, equity considerations which go beyond the purely scientific aspects of economics because they draw upon important ethical judgments also have influenced current decisions. Probably decisions seeking enrollment of blacks and other disadvantaged groups, and certainly current decisions adjusting tuitions through increased student aid based on ability-to-pay are examples of this.

In summary, the analysis of actual investment decisions over time can aid in understanding and isolating some of the major overall influences on these decisions, contribute to more dependable predictions, and (in relation to normative goals) aid in planning toward achieving growth, stability and equity. For it is in the best interest of society that the nation's total resources be allocated as efficiently and as equitably as possible.

Chapter 2

The Basic Theory of Decisions to Invest in Higher Education

Most decisions to invest in higher education are made while giving consideration to the return flows of income and non-monetary satisfactions expected in future periods. This multiperiod orientation to the future makes them similar to other types of investment decisions that are made by households, businesses, and governmental units.

The logical place to start is with an analysis of investment in human educational capital by households. For investment in education, just as with investment in health, involves household production of human capital using relatively large amounts of the household's own time. The educational capital stock is produced to last over the family's life cycle, it becomes a component of society's total stock, and it is financed in large part by the household out of its own resources. It is on knowledge of the influences on these private investment decisions that public policies designed to be effective in improving allocative efficiency and achieve equity must build.

An economic model is required that analyzes actual investment decisions, as distinguished from assuming optimal responses to expected rates of return, to better understand why underinvestment or overinvestment can occur. The purpose of this chapter is to develop a basic economic model of this type, emphasizing the short term dynamics of the investment process as well as taste-habit and short term family budget constraint effects. By giving special attention to those determinants basic to fluctuations and growth in investment in higher education, an underlying logical framework will be developed that will be useful in the subsequent analysis of aggregate investment over time.

This focus on shorter run actual decisions to invest in human capital addresses itself to an important theoretical and empirical gap in the human capital literature. T. W. Schultz (1971),p. 155, who has made many important contributions to this subject, feels that "we know very little about the tendency to equilibrium or about the responses to relative rates of return." Freeman's (1971), p. 19, useful recent study on the Market for College-Trained Financial Manpower contains a "labor supply equation" and deals with the market dynamics, but it focuses on the choice between fields in response to expected lifetime incomes, or relative rates of return reflecting relative demands, rather than on the overall decision to invest. It also does not consider taste-habit effects, expected non-monetary returns, and the effects of short term family budget constraints. Beyond this, relevant basic contributions to the theory of the use of time in household production have been made by Becker (1964, 1965), Ben-Porath (1967) and Grossman (1972), and to the allocation of time over the life cycle by Ghez and Becker (1972). These have noted the higher short run shadow price of human capital, but none have considered the taste-habit, existing stock, or expected non-monetary return effects on actual investment decisions. None deal primarily with the short term dynamics of the investment process.

I. THE BASIC DYNAMIC MODEL

The basic dynamic model involves a short term dynamic adjustment process typical of that found useful in many other branches of investment theory e.g., Jorgenson (1971), pp. 1111-47. Individual families are assumed to inherit an initial stock of educational capital that can depreciate over time as new knowledge causes obsolescence and that can be increased by investment. To invest by producing educational capital, families and other cooperating decision units generate derived investment-demands for formal higher education. But since investment in educational capital requires a process of learning that takes considerable time, desired or equilibrium levels of education capital stocks, S^*_{ET}, cannot be attained immediately. Therefore a dynamic stock adjustment model is appropriate. With the production of educational capital implicit (in the θ), the derived demand for formal higher education to be used as an input is:

$$(1) \quad I_{HHT+F} = \theta(S^*_{Et} - (1-\delta)\, S_{Et-1})$$

Here: I_{HHT+F} = real investment expenditures by households on tuition and fees,

S^*_{Et} = equilibrium educational capital stocks,

S_{Et-1} = actual stocks, stocks dated as of the end of the preceding period,

δ = a rate of depreciation that includes obsolescence,

θ = a dynamic adjustment coefficient, less than one in the short run, reflecting the implicit household production function for educational capital.

An adjustment coefficient of less than unity assumes a partial response (giving what is equivalent to a geometric distributed lag) to the difference between desired and depreciated actual stock levels since the learning process normally takes many years. The speed of adjustment is affected by the elasticity of output with respect to formal educational inputs as human capital is produced.

The equilibrium stock of educational capital depends upon expected returns, the decision unit's tastes and goals, and shorter term economic constraints to be developed later in this chapter. For undergraduate education:

$$(2)\quad S^{*}_{Et} = f(Y_{Dt}, Y^{e}_{Bt}, P_{Et}, S_{Pt-1}, C_{18-26}, u_{t})$$

Where Y_{Dt} = current real disposable income,

Y^{e}_{Bt} = the difference in expected average annual income of a college graduate (B = Bachelors Degree) over that of a high school graduate,

P_{Et} = the shadow price of educational capital,

S_{Pt-1} = psychological stocks of tastes and habits,

C_{18-26} = stocks of potential college students, undergraduate and graduate, treated as a family taste parameter, and

u_{t} = non monetary goals of the decision unit.

Equation (2) is substituted into equation (1) to obtain the estimating equation.

This basic dynamic model given by equations (1) and (2) is used in Chapter 3 for empirical analysis of aggregate investment by households in higher education over time. With appropriate extensions, this basic model will also be used in Chapters 4 and 5 for the analysis of investment in higher education by governmental units. By reinterpreting human capital stocks as disembodied stocks of knowledge, the model can also be used in the study of investment in the creation of knowledge through university-based research in Chapter 6. The appropriate adaptations will be made at these later points. The remainder of this chapter will focus on the derivation and refinement of the basic model, and on the development of testable hypotheses as they apply to investment in higher education over the life cycle by an individual family.

II. FAMILY PRODUCTION OF EDUCATIONAL CAPITAL

Additions to the stock of educational capital are produced by individual families in the expectation that the embodied knowledge will return future flows of earnings and non-monetary returns.

Let ss_{1t} be the percent of the family's total time (i.e., the percent of its total educational capital stock S_{Et-1}) devoted to the production of educational capital, and q_t the quantities of formal educational inputs used in production as above. Then Q_{Et}, the gross additions to the stock of educational capital, are given by the following household production function:

$$(3) \quad Q_{Et} = \beta_o (ss_{1t}S_{Et-1})^{\beta_1} q_t^{\beta_2}, \qquad t = T, \ldots L.$$

ss_{1t} is the proportion of the family's total time (i.e., of its total educational capital stocks), so s is the proportion of its work-time used to produce human capital. The remaining portions are allocated to gainful employment, $(1 - s)s_{1t}$, and to leisure $(1 - s_{1t})$. β_o is a shift parameter reflecting the managerial efficiency with which parents employ their skills to assist in the production of educational capital (e.g., Michael (1969, 1972)). No theoretical case is made for use of the Cobb-Douglas form. It is used only because it is a simplified yet reasonable first approximation of the more general form $Q_{Et} = Q(ss_{1t}S_{Et-1}, q_t)$ and because it permits a simpler derivation that will contribute to clarity in the presentation. In this event, β_1 and β_2 are production elasticities, with β_2 dependent on the student's ability as reflected in test scores.

Thus β_2 indicates the efficiency with which a given quality of higher educational opportunities can be utilized by the student.

There are both time and cost constraints on the production of human capital. The time constraint is:

$$(4) \quad ss_{1t} S_{Et-1} + (1-s)s_1 S_{Et-1} + (1-s_{1t})S_{Et-1} = S_{Et-1}$$

This simply says that the proportion of time (stock) devoted to educational capital formation, plus time used for work, plus the proportion of time used for leisure (consumption time)must add to 100%. The investment cost constraint defines the family's total investment in education $P_{Et}Q_{Et}$ in terms of outlays of tuition and fees, room and board, and "excess" foregone earnings:

$$(5) \quad P_{Et}Q_{Et} = P_{T+F}q_t + P_{R+B}q_t + (w\ ss_{1t}S_{Et-1} - P_{R+B}q_t)$$

Hereafter P_{T+F} = the net tuition and fee "price" to the household of formal education,

P_{R+B} = a similar "price" for room and board, and

w = the wage rate the student could have received per unit of employed educational capital, so

$wss_{1t}S_{Et-1}$ = foregone earnings invested in educational capital.

The excess of foregone earnings over room and board payments will be referred to as "excess" foregone earnings, although it can be negative, especially in periods when there is considerable unemployment. Room and board payments will be studied separately from foregone earnings in the empirical analysis because out-of-pocket room and board costs are a measure of the proportion of the student's foregone earnings that are usually absorbed by the parents as they make explicit expenditure decisions. Lower room and board costs may be a significant factor in the expansion of junior colleges.

The long run costs to the family of producing additions to its stock of educational capital now can be derived. Treating the quantities of formal educational inputs purchased, q_t, and the percent of total time used in educational capital formation ss_{1t}, as variables, additions to the stock of educational capital Q_{Et} in (3) can be maximized subject to investment cost (5) and time (4) constraints. These costs over the family's entire life cycle are the LRMC in Figure 1 or its long run supply curve for educational capital.

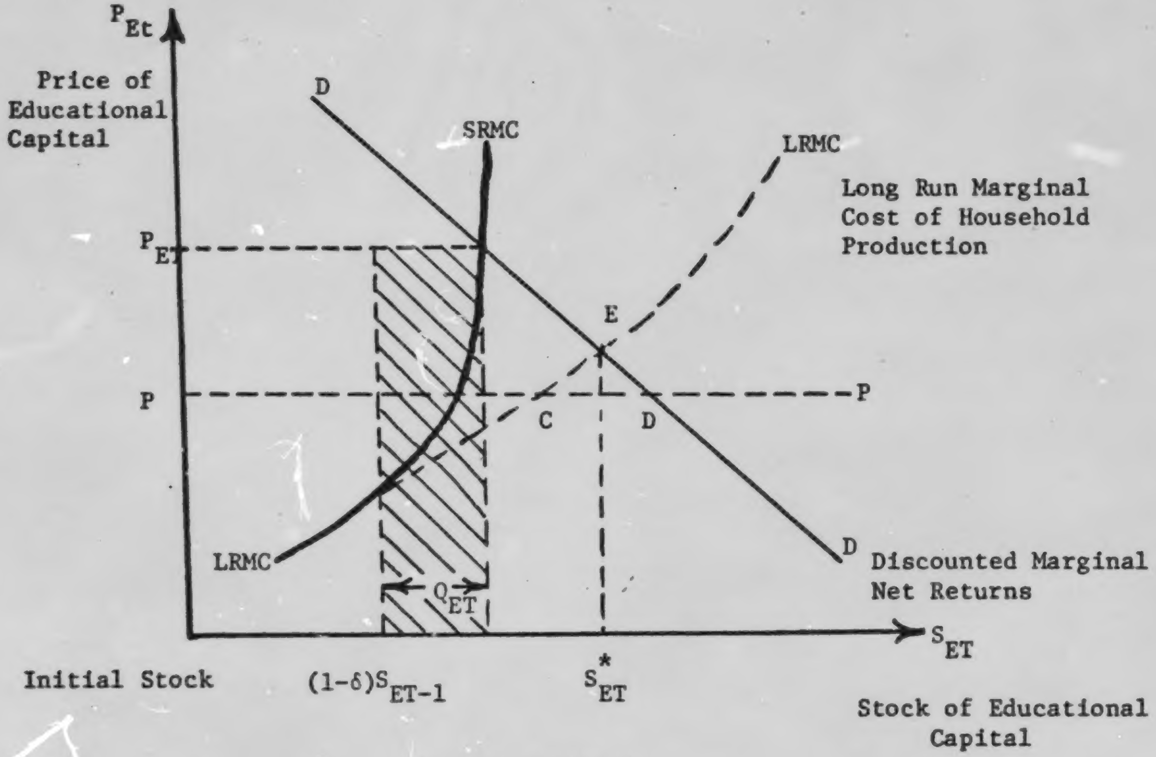
P_{Et}
Price of Educational Capital
D
SRMC
LRMC
Long Run Marginal Cost of Household Production
P_{ET}
E
P
C
D
P
LRMC
D
Discounted Marginal Net Returns
Q_{ET}
S_{ET}
Initial Stock
$(1-\delta)S_{ET-1}$
S^*_{ET}
Stock of Educational Capital

FIGURE 1

Investment in Educational Capital, Long (S^*_{ET}) and Short (Q_{ET}) Run

The long run marginal cost curve slopes upward where $(\beta_1 + \beta_2) < 1$ and under long run conditions where educational capital stocks S_{Et-1} and their allocation to the proportion of new human capital ss_{1t} are variable so that the stock term is not an effective constraint. The diseconomies of scale illustrated in Figure 1 need not be assumed in order to obtain a long run equilibrium solution because reasons for a downward sloping demand curve exist (see Part III below). After demand is considered, the family's desired stocks S^*_{ET} are obtained as illustrated at point E in Figure 1. The short run solution also is illustrated in Figure 1.

III. LONG RUN INVESTMENT DEMANDS FOR EDUCATIONAL CAPITAL

The total demand over the life cycle for educational capital shown as DD in Figure 1 will be obtained by maximizing lifetime utility flows subject to a multiperiod budget constraint. When lifetime money income in this constraint is not taken as given, but instead is treated as a variable determined primarily by the investment made in educational capital, the career-related portion of the total demand for educational capital may be derived. The partial solution for this at point C has been developed previously by Ben-Porath (1967). An additional demand (e.g., distance CD) exists based on additional expected non-monetary private satisfaction ranging from the non-monetary and child-rearing benefits associated with the education of those women who do not plan to enter the labor force full-time to greater access to social and cultural leisure time opportunities. These become part of the more general long run equilibrium solution. This new long run equilibrium solution now will be developed more completely.

Flows of Expected Satisfactions

To derive the family's total non-money and money-income-related investment demands for educational capital, its multiperiod ordinal utility function may be stated simply, but generally, as follows:

$$(6) \quad U_T = U\,(x_{ot},..,x_{nt},\alpha_{ot},.,\alpha_{nt}), \qquad i=o,1,.,n;t=T,.,L.$$

$x_o,\ldots,x_n$ = consumption service flows from all consumer capital stocks and other goods, with i=o=non-monetary satisfactions flowing directly from the stock of higher education ,

$\alpha_o,\ldots,\alpha_n$ = a set of taste parameters,

U_T = utility as viewed from the current period T, expressed as dependent on current and expected future service flows since t=T,..,L. The function U includes therefore an implicit rate of discounting of expected future utilities, and

L = the last period in the family's life cycle, defined as the expected date of death of the last parent.

Since the family is the basic unit of analysis, its last period will include the discounted future satisfactions of any remaining children as of that date. The implicit rate of discounting of all future utilities can reasonably be assumed to be positive, with $\mu_t>0$. If events in the more distant future are more uncertain with more widely dispersed probabilistic values, and if families are risk averse, then the conversion to certainty equivalents implies heavier positive discounting of future utilities. Students are unsure about their abilities, and hence their future income (and the utility it can generate) is more uncertain. The classical Fisherian conditions are not appropriate in this case, and it is likely that expected future income is discounted by more than the family's real marginal time preference under conditions of uncertainty so that $\mu_t > 0$.

The taste parameters α_{it} represent psychological stocks of tastes and habits. They are assumed to be based primarily on the parents' past experiences with the returns from higher education. These affect the perceptions of education that the parents transmit to the student. This interpretation of taste-habit parameters as psychological stocks is consistent with recent work by Gorman (1967), Houthakker and Taylor (1970) Pollak (1970), and von Weizsäcker (1970). It merely defines taste parameters as psychological stocks:

$$(7) \quad \alpha_{it} = \alpha(S_{Pt-1}, u_t) \qquad i = P=0,\ldots,n.$$

Where S_{Pt-1} = psychological stocks of tastes and habits accumulated through past consumption experiences:

$$(8) \quad S_{Pt-1} = S(\sum_{t=0}^{t-1} (x_{it} - \beta x_{jt})), \ \frac{\partial S_{Pt-1}}{\partial x_{it}} \geq 0 \qquad i=P, i \neq j, i=o,..,n.$$

Direct past service flows x_i are assumed to be dependent primarily on the parent's past education. x_j represents cross effects from newly perceived goods, or from forgetting, that displace existing tastes. When $i=o$, x_i represents past experiences with the non-monetary service flows from education; when $i=1,\ldots n$ it represents past experiences with the income and career related returns from education.

Channels of communication do not always transmit these tastes effectively from parents to the young adults. As students have their own experiences with the service flows from higher education (x_i) they may find a lack of reinforcement, or they may have experiences with other commodities (x_j) that are equivalent to those from "new goods." Tastes and habits based on these new experiences then may gradually displace the tastes for education held in common with the rest of the family. With the student's financial independence, his own tastes would no longer be only partially implemented. However even at that time, his own independent tastes will not necessarily differ significantly from those of his parents. Thus learning based on direct experience with service flows provides for a continual re-appraisal of utilities over the life cycle as part of an adaptive process.

The taste parameters depend not only on these psychological stocks of tastes and habits for higher education. The presence of potential students in the household offers new investment opportunities to the family. This calls for use of some kind of a scaling factor measuring the number of current and potential students in the family, say C_{18-26}. This also may be regarded as a shift in the family's taste parameters:

$$(9) \quad \alpha_{it} = \alpha(S_{PT-1}, C_{18-26}), \; \frac{\partial\alpha_{it}}{\partial S_{PT-1}} > 0, \; \frac{\partial\alpha_{it}}{\partial C_{18-26}} > 0, \; i=P=o,..n, t=T,..,L.$$

Equation (9) focuses on sources of differences in tastes among households, as well as differences over time.

Tastes include the family'a appreciation of externality-type social benefits of education even though S_{PT-1} and C_{18-26} in equation (9) gives greater prominence to purely private benefits. But it is often assumed that social benefits are shared more or less equally by all households, and that the public sector is needed to make effective this part of the demand since the exclusion principle fails to operate in this case.

Note also that taste parameters applying to expected future service flows, α_{it} in (9), are actually expectations that are held as of the current period T. Since these current tastes are the only ones that can possibly affect current investment decisions, all tastes are shown as totally dependent on psychological stocks held in the current period.

Finally taste parameters are not derived as an optimal rule, but instead tastes defined by equation (9) and the stocks on which they depend are taken as given by learning theory. This procedure is mindful of Marshall's dictum that "Economists should start with preferences and build upon them, taking them as given", (Schultz (1971)). Marshall didn't mean that differences in preferences among families either can or should be ignored. They exist for example in cross section analysis and must be taken into account. He also did not mean that tastes although given are necessarily constant in the long run. We do assume here, however, that the stocks on which tastes depend are both given and fixed in the short run, since psychological stocks of habits and "stocks" of children change more slowly than the flows which increase or reduce their size. There may be disturbances (e.g., the Viet Nam War campus demonstrations) that cause occasional short run shifts. But the relative inflexibility of stocks in the short run, and the distinction between the short and long run when using equation (9), offer a workable solution to the dilemma.

Consumption Service Flows Yielded by Capital Stocks and Time

The consumption service flows that appear in the utility function are produced by use of consumer capital stocks, purchased market goods, and the family's own time. In particular, the flow of non-monetary satisfactions from the stock of educational capital, x_{ot}, are "produced" by the family using its leisure time $(1 - s_{1t})S_{Et-1}$ and the non career oriented liberal and homemaker education direct services from its educational capital S_{ot}:

$$(10) \quad x_{ot} = \gamma_o((1 - s_{1t})S_{Et-1})^{\gamma_1} S_{ot}^{\gamma_2}$$

All other commodity flows are produced in a similar fashion, letting $i=o,1,\ldots n$, in ways that have been developed previously by Becker (1965), p. 495, and others. So those production functions for x_{it} can be substituted into the utility function (6) in place of the consumption flows:

$$(11) \quad U_T = U(S_{it}, (1-s_{1t})S_{Et-1}, \alpha_{it}), \; i=0,..,n, t=T,.,L.$$

Utility becomes a function of consumer capital stocks S_{it}, the household's leisure time $(1 - s_{1t})S_{Et-1}$, and the taste parameters.

The Multiperiod Budget Constraint

The household's total desired investment in educational capital formed through higher education is derived by maximizing the multiperiod utility function discussed above, subject to the multiperiod budget constraint. The constraint must be considered in its entirety for clarity; it says simply that current and expected money income, foregone earnings due to leisure, and initial salable assets equal total expenditures on goods over the remainder of the life cycle, the value of leisure time, and terminal assets. It is:

$$(12)\quad Y_{DT} + \sum_{t=T+1}^{L} \frac{Y_t^e}{(1+r)^{t-T}} + \sum_{t=T}^{L} \frac{w(1-s_{1t})\bar{S}_{Et-1}}{(1+r)^{t-T}} + \frac{wS_{ot}}{(1+r)^{t-T}} + \sum_{j=1}^{n} p_{jT}S_{jT-1}$$

$$= \sum_{t=T}^{L} \sum_{i=0}^{n} \frac{p_{it}q_{it}}{(1+r)^{t-T}} + \sum_{t=T}^{L} \frac{w(1-s_{1t})\bar{S}_{Et-1}}{(1+r)^{t-T}} + \frac{wS_{ot}}{(1+r)^{t-T}} + \sum_{j=1}^{n} \frac{p_{jL}S_{jL}}{(1+r)^{L-T}}$$

Y_{DT} = current real disposable personal income from labor (human capital), and property,

Y_t^e = expected real disposable personal income from labor and property for periods $t = T+1,\ldots,L$,

S_{jT-1} = stocks of all resalable assets, with S_{jL} = terminal assets. Note that initial assets are not regarded as the discounted value of property income but are held with interest income included in Y_{DT} and Y_t^e, and then eventually spent, distinguishing stocks from income flows.

S_{Et-1} = the stock of educational capital. Since $(1-s_1)$ is the fraction of time spent in leisure, and w the wage rate, $w(1-s_1)\bar{S}_{Et-1}$ gives the value of the time (stocks) used indirectly to produce non-monetary consumption services, and wS_{ot-1} of flows yielded directly, with $S_{Et-1} = \bar{S}_{Et-1} + S_{ot-1}$.

p_{T+Ft} = current tuition and fee price of q, (expected future values when $t = T + 1,\ldots L$),

q_t = current quantities of formal education purchased, (when $t = T$), and

r = a cumulative mean of expected rates of return on assets.

Before maximizing utility subject to the lifetime budget constraint it is necessary to convert the stocks that appear in the utility function into the quantities of formal higher education to be purchased which appear in the budget constraint, for they are the primary objective of this analysis. Notice that the quantities of formal higher education purchased are a derived demand for an input (Max (3) s.t. (5) and solve for q_t. That is:

$$(13) \quad q_t = \frac{\beta_2}{\beta_1+\beta_2} \frac{1}{P_{T+Ft}} (P_{Et}Q_{Et})$$

This derived demand for formal higher education depends in turn on the family's desire to adjust its educational capital stocks:

$$(14) \quad Q_{Et} = \theta_E(S^*_{Et} - (1-\delta)S_{Et-1})$$

This adjustment when substituted into (13) gives the long run derived demand for investment in formal higher education (θ=1) shown here and illustrated as D*D* in Figure 2:

$$(15) \quad P_{T+F}q_t = \frac{\beta_2}{\beta_1+\beta_2} P_{Et}[S^*_{Et} - (1-\delta)S_{Et-1}], \qquad S_{Ft} = S_{ot} + \overline{S}_{Et}$$

The short run adjustment is obtained when $\theta_E < 1$ and the derived demand in (13) is calculated for the short run. P_{Et} becomes more flexible upward, and additions to the stock are limited to Q_{Et} as is illustrated at point B in Figure 1. So the short term derived demand for formal higher education using (13) and (14) involves a short term investment flow equilibrium that was given by equation (1) and is illustrated at E_o in Figure 2.

IV. INVESTMENT IN HIGHER EDUCATION: LONG AND SHORT RUN

But to derive both the long and short term derived investment-demands for formal higher education, D*D* and DD respectively in Figure 2, the equilibrium capital stock S^*_{Et} which appears in both must be obtained. It is the total stock composed of portions yielding direct non-monetary returns S^*_{ot}, including those from a liberal education,

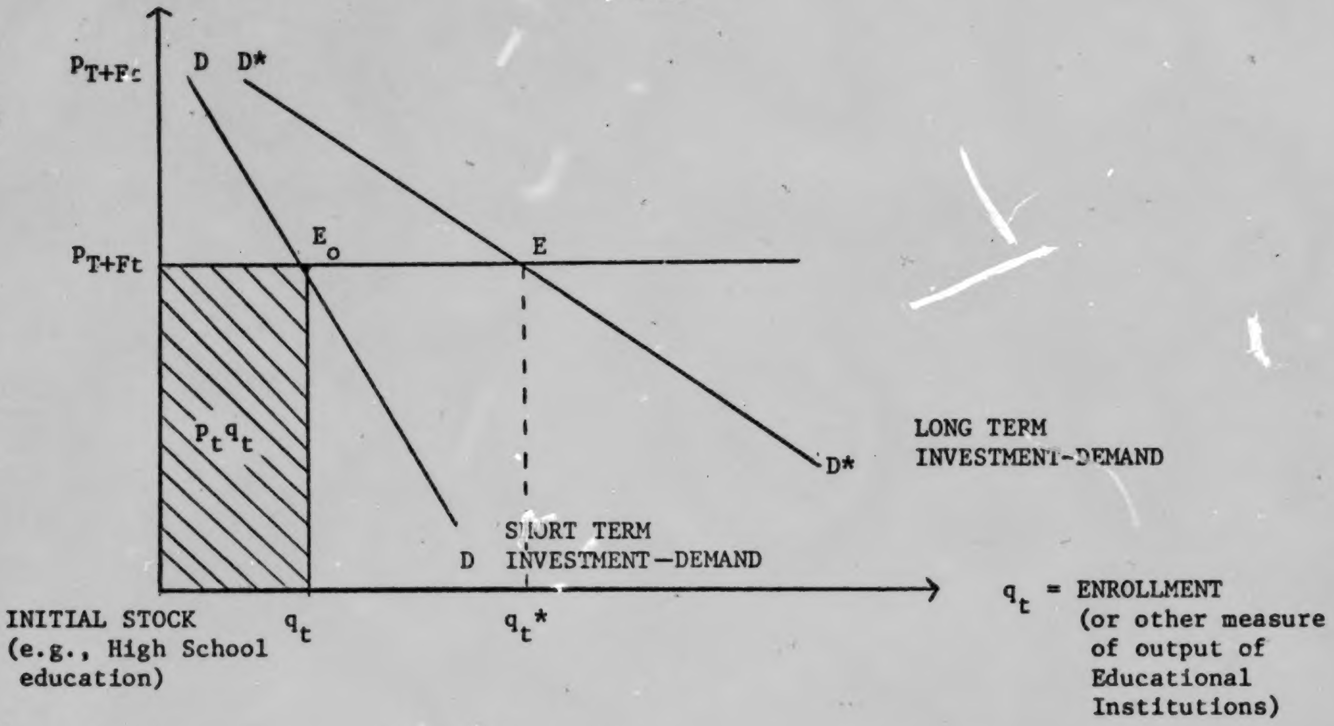

FIGURE 2

homemaker education, and non-monetary returns on the job, plus a producer-oriented stock $\bar{S}^*_{Et}$ used to produce income, human capital, and commodity service flows in combination with other goods, such that $S_{Et} = S_{ot} + \bar{S}_{Et}$ as was indicated in (12) and (15).

A portion of the producer-oriented stock ($\bar{S}_{Et}$) is desired as a means of producing money income during work-time $s_{1t}(1-s)\bar{S}_{Et-1}$, or for re-investment in the production of additional educational capital during human capital formation time $s_{1t}s\bar{S}_{Et-1}$. It will be considered first. It does not appear in the utility function directly since it is converted either into more human capital or into money earnings. Both then contribute to utility either through purchases or production of consumption satisfactions.

Education to Optimize Earnings

The thrust of much of the research on investment in human capital in recent years has been to show that current and expected income in the budget constraint, Y_{Dt} and Y^e_t, are not given but are determined by investment in formal education, as well as in health and on the job training. To determine the family's optimal career-related stock of higher educational capital, shown as distance PC in Figure 1, the family must maximize the present value of the current and expected income to be derived from its stock of higher education, net of its total cost of investing in higher education. This is the part of the solution developed previously by Ben-Porath (1967), pp. 354-56. We extend it here by explicitly recognizing property income, and by focusing on higher education.

The family's current and expected income, based on its (initial) high-school education, college education, and resalable assets is:

$$(16) \quad Y_{Dt} = Y_{HSt} + ws_{1t}(1-s)\overline{S}_{Et-1} + r \sum_{j=1}^{n} p_{jt} S_{jt-1} \qquad t=T,..,L.$$

Here Y_{HSt} is labor income available to the family members who stop with a high school education. Market rates w for college level skills and r for financial assets each are given parameters from the point of view of a single family since they can be assumed to be unaffected by the supply of educational and financial services it offers. (The quantities are taken to be of a given homogeneous quality for this family.) Income is increased by having larger stocks of human and financial capital to offer. To focus on the incremental demand for higher education, S_{Et-1} is limited to the stock of higher education. The initial stock includes a high school education and is taken as the base from which measurement occurs. It is shown at the origin in Figures 1 and 2.

To maximize the present value of this current and expected income stream, the family would need to maximize the present value of its money earnings from use of the undepreciated part of its higher-education capital stock, plus the present value of its other labor and property income, a total shown in the numerator on the left in (17). To optimize this net of costs is equivalent to finding $\bar{S}^{*}_{Et-1}$ by equating marginal monetary returns from additional higher education to marginal investment costs. That is:

$$\text{(17)}\qquad \frac{\partial \sum_{t=T}^{L}\left[\frac{ws_{1t}(1-s)\bar{S}_{Et-1}}{(1+r+\delta)^{t-T}} + \frac{Y_{HSt} + r\sum_{j=1}^{n} P_{jt}S_{jt-1}}{(1+r)^{t-T}}\right]}{\partial \bar{S}_{Et-1}} = \frac{\partial \sum_{t=T}^{L}\frac{(LRMC)_{t}}{(1+r)^{t-T}}}{\partial \bar{S}_{Et-1}}$$

This merely sets the marginal monetary returns on the left (to which expected marginal non-monetary returns in (18) must be added), equal to long run marginal total cost of household production of higher education capital which has been derived previously (by max. (3) s.t. (4,5)). Note that the marginal returns are independent of the size of $\bar{S}_{Et-1}$ in (17), and hence of S_{Et-1}, giving a demand price P in Figure 1 that is horizontal and not downward sloping.

Marginal investment costs refer to total costs of higher education including the costs of that part expected to yield non-monetary returns. They include therefore the liberal arts courses that are included in most college and university requirements, as well as the costs to the household of educating future homemakers. Therefore (17) constitutes only a partial solution.

Non-Monetary Returns and Equilibrium Total Demands for Higher Education

The family must also consider the expected non-monetary returns from higher education that are expressed in its utility function. These are the returns yielded by S_{ot} in the form of direct access to cultural opportunities and by $(1-s_{1t})\ S_{Et-1}$ in the form of its contribution to the production of consumption satisfactions during leisure hours. Obtaining equilibrium non-monetary returns requires maximization of the multiperiod utility function.

Therefore substitute (18) and (19) into the multiperiod budget constraint for purchases of formal higher education and of all other goods respectively:

$$(18)\quad P_{T+Ft}q_t = \frac{\beta_2}{\beta_1\ \beta_2}\ P_{Et}\,\Theta_E[S^*_{Et} - (1-\delta)S_{Et-1}] \qquad i=0$$

$$(19)\quad P_{it}q_{it} = P_{it}\Theta_i\ [S^*_{it} - (1-\delta_i)S_{it-1}] \qquad i=1,..,n.$$

$\Theta = 1$ in the long run for educational capital, durables, and houses, and $\Theta = 1$ for consumer services at all times.

A first approximation to the optimal time path of disposable income, Y_{Dt} and Y^e_t, has been obtained as described above (i.e., by determining optimal investment in career-related higher education $\bar{S}^*_{Et}$, with expected leisure and assets treated as predetermined, to yield Y_{Dt} by (16). The next step is to find the optimal time path of all consumption stocks, S^*_{it}, (i=0,1,..n; t=T,..L), since this will include the long run demand for non-monetary higher education stocks S^*_{ot}(t=T,..L) needed to obtain S^*_{Et} in (18) above as well as S^*_{it} in (19). Optimum stocks are obtained by maximizing utility (11) subject to the modified multiperiod budget constraint (12) with respect to all S_{it}.

Now the long run optimal time path of consumption expenditures may be obtained using (18) and (19). Since Y_{DT} and Y^e_t have been previously determined, optimal saving flows over the family's life cycle are secured as a residual. Note that the choice between work and leisure in s_{1t} has been treated as a parameter. Later in its life cycle, after periods of full time formal education have come to an end, the choice between work and leisure may again be brought under review. The point has been developed quite convincingly by Ghez and Becker (1972), that as earning capacity increases, the foregone earnings that represent the price of leisure also increase, inducing some substitution toward longer hours of work (s_{1t}) and away from leisure ($1 - s_{1t}$).

The long run investment-demand for higher educational capital S^*_{Et}, and hence for higher education (by (18)) requires one final step. The equilibrium stocks of education S^*_{ot} at each point in time t=T,..L yield expected flows of non-monetary satisfactions x^*_{ot}, t=T,..L by (10). To be consistent with the capital-theory treatment of expected earnings, these must be summed and discounted back to their present value. These expected benefits then are maximized by adding them to expected monetary returns before the comparison is made to costs. The discounted present value of the expected non-monetary returns are:

$$(20)\quad \frac{\partial \sum_{t=T}^{L} \frac{f_o(S_{ot}, S_{Et-1}, p_{ot})}{(1+r)^{t-T}}}{\partial S_{ot}} + \frac{\partial \sum_{i=1}^{n} \sum_{t=T}^{L} \frac{f_i(S_{it}, S_{Et-1}, p_{it})}{(1+r)^{t-T}}}{\partial S_{Et-1}}$$

These expected non-monetary returns must be added to the expected monetary returns on the left side of (17) to obtain the final equilibrium educational capital stock. It moves the solution from Ben-Porath's point C in Figure 1 to the point labeled S^*_{ET}.

These two expected non-monetary benefits from higher education both contribute to the downward slope in the total demand for educational capital illustrated in Figure 1. There is diminishing marginal utility of the satisfactions yielded by liberal and homemaker education portions of the total educational capital stock, to be found on the left in (20) above. Beyond this, there is diminishing marginal productivity as the total educational capital stock is used during leisure hours (on the right in (20)) to produce flows of satisfactions in combination with other goods for the family. Unless there are enormous economies of scale in household production of educational capital, a finite equilibrium stock of educational capital such as that at S^*_{ET} in Figure 1 is assured.

Since total investment demand shifts downward with time as the family moves forward through its life cycle, (i.e., as $T \to L$ in (17)), new investment must eventually cease.

Chapter 3

Investment by Families in Higher Education, 1929-1980

Most of the costs of investing in the human capital that is created by higher education are borne by families. Families normally cover tuition, fee, room, board, and extra foregone earnings costs, and the family is also the basic decision unit that normally arranges for the production of new educational capital. The resulting improvements in the quality of the labor force, which include those made through professional education, may well be an important source of differences in per capita income between the United States and other countries (Denison (1968), Krueger (1968)), as well as of higher productivity within firms, (Welch (1970)). The benefits of higher education when extended to a larger percentage of the population as they have been in the U.S. may also contribute to greater equality in the distribution of income (Kuznetz (1966)), and in other ways affect the quality of human life (Bowen (1971)).

But in spite of the overwhelming importance of these growth and income distribution implications for the welfare of societies there has been surprisingly little economic analysis of the determinants of investment in higher education by families over time. Much of the inter-temporal analysis of expenditure or of enrollment has tended to merely extrapolate trends without analyzing the influences on family investment decisions, or to consider manpower requirements that focus on differences in demands among job markets. Another approach which is limited but also useful for some purposes has been to base projections on demographic statistics alone.

This chapter will analyze, therefore, the more important influences on investment by families in higher education over time. Investment models will draw upon the analysis of the investment process that was developed in the preceding chapter, with special attention given to sources of fluctuations and growth of investment over time.

To study investment in higher education by households over time in ways that permit simultaneous consideration of the most interesting explanatory variables requires the use of aggregates. Longitudinal data on individual families that contains measures of these variables and that has been collected over a long enough period of time simply does not exist. So from the point of view of testing hypotheses about individual family investment decisions, the use of aggregate data produces results that must be viewed as only explanatory. However, on reasonable working assumptions, the aggregates do reveal influences on total investment that are strong enough and pervasive enough to affect the totals without being netted out by the countervailing actions of other micro units or by cross effects. This is useful information in its own right. It can also help to identify some of the more important hypotheses to test further in microeconomic data as more adequate longitudinal data on individual families gradually becomes available.

In Part I, the theory of investment in higher education by families is briefly considered, together with relevant prior research, as a means of selecting hypotheses that are related to a logical framework. The hypotheses selected for discussion are also ones that show good promise of being empirically significant. Most have some relation to the design of current public policies or the needs of society. Part II discusses measurement of the variables. Part III presents regression results for models dealing with investment expenditures (with tuition and fees, room and board, and total investment considered separately)

These models deal separately with investment made by families through use of public and private institutions. An enrollment model estimated by restricted three stage least squares simultaneous equation estimating methods, with a priori restrictions placed on certain of the parameters as shown in Table 7 to allow (separately determined) effects of state and federal subsidies.

I. THE BASIC DYNAMIC MODEL

Central to the concept of human capital accumulation, and hence to a generalized capital accumulation approach to growth (Johnson, 1964), is the concept of a stock of educational capital. A stock of education possessed by a family, or by all families in the society, raises problems of measurement (discussed in Appendix B), and also implies that there is some kind of stock adjustment. This stock adjustment is very likely to be incomplete in the short run.

A Family Investment Function. Families adjust their stocks of educational capital annually by amounts that are limited by the time required by the learning process. This implies a short term dynamic stock adjustment mechanism, with actual stocks of higher education capital possessed by families, S_{Et-1}, gradually adjusted toward their desired, or equilibrium, level, S^*_{Et}, as shown in equation (1):

$$(1) \quad I_{Ht} = p_{it}q_{it} = \Theta_i[S^*_{Et} - (1-\delta)S_{Et-1}]$$

$p_{it}q_{it}$ = Investment in higher education by households (I_{Ht}), annually in constant (1958) dollars,

Θ_i = the short term dynamic adjustment coefficient,

S^*_{Et} = educational capital stocks desired by families,

S_{Et-1} = actual stocks, as of the end of the preceding period,

δ = the rate of depreciation and obsolescence of educational capital.

This investment-demand for higher education results from a partial adjustment of actual educational stocks by families toward their desired level, ($\Theta \leq 1$). Desired, or equilibrium levels are given by family tastes and economic circumstances as shown in equation (2), which will always be substituted into equation (1) to replace S^*_{ET} prior to estimation.

New knowledge created by research has two effects. It causes actual stocks of human capital to become obsolete at the exogenously given rate δ, so that actual stocks are depreciated and need to be replaced, as seen by δS_{ET-1} in (1). It also creates new opportunities for investment in human capital, at rate ρ, increasing S^*_{ET} (below). Although new knowledge therefore incurs social costs, especially among older people who no longer find it feasible to invest(since their investment demands have shifted downward with age), it also offsets diminishing returns to educational capital by making existing stocks obsolete. More positively, research also opens up new investment opportunities, and the rates ρ and δ will be made endogenous and dependent primarily upon new basic research in Chapter 6.

The speed of adjustment (θ_i) is affected by the elasticity of output of educational capital produced by households with respect to changes in formal educational inputs. But in addition to the technological restrictions on the production function that lie behind this demand, the proportion of the gap between actual and desired that is closed in any one year also depends on the time constraint restricting the amount learned, and on the short run budget constraint. Time becomes important in a production process as slow as that for educational capital. The 16 years normally required to reach a Bachelors degree is perhaps the longest gestation period to be found for any major category of capital. Current income becomes important because of the sizable borrowers risk (given uncertain, uninsured, potentially low payoffs), large lenders risk (since educational capital cannot be repossessed), and greater attractiveness of parental income to all participants as a source of finance.

The educational capital stock desired by all families is hypothesized here to be given by the following:

(2) $S^{*}_{Et} = f(Y_{Dt}, Y^{e}_{Bt}, P_{Et}, \rho, \alpha_{Et})$, $\alpha_{Et} = \alpha(S_{Pt-1}, C_{18-26}, u_{t})$

Y_{Dt} = current real disposable personal income,

Y^{e}_{Bt} = the absolute difference in real disposable personal income of a college graduate (B = bachelors level) over that of a high school graduate,

P_{Et} = the shadow price of educational capital,

ρ = rate of technical change, leading here to new opportunities for investment in human capital, and dependent (later) on basic research,

α_{Et} = Tastes for higher education, dependent on the parents' education (S_{Pt-1}) and on the number of children of college age (C_{18-26}) as a percent of the population, and

u_{t} = disturbances.

The basic investment function to be estimated can now be obtained by substituting (2) into (1), which eliminates S^{*}_{Et}, and by postulating homogeneity in prices, which eliminates P_{Et} (see equations (15) and (18) in Chapter 2). The result is as follows:

(3) $p_{it}\, q_{it} = I(Y_{Dt}, Y^{e}_{Bt}, \rho, S_{Pt-1}, P_{E}S_{Et-1}, C_{18-26}, u_{t})$.

All variables are as previously defined. This investment function will be estimated separately for investment at public and at private institutions, so $p_{it}\, q_{it}$ represents total investment by households at each in turn. The stock of higher educational capital ($P_{Et}S_{Et-1}$) is now in value terms because of (18) in Chapter 2. In addition to total investment, equation (3) will be estimated for investment via tuition and fees, and family investment via room and board at each type of institution, the two major components of investment which with excess foregone earnings above room and board costs add to total investment by families.

Dropping the postulate of linear homogeneity in prices, p_{it} and p_{jt} appear above in place of u_t. p_{it} will in all cases represent an "own price," so that if, for example, the dependent variable is total investment in tuition and fees at public institutions in constant dollars, p_{it} would be an index of tuition and fees per student at public institutions in constant dollars. p_{jt} represents the price of a potential substitute or complement, so that if $p_{it}\ q_{it}$ is total investment at public institutions, p_{jt} would represent an index of the total investment price of educational capital per student (i.e. P_{Et}) but at private institutions.

II. HYPOTHESES AND MEASUREMENT OF VARIABLES

Macroeconomic hypotheses concerning the significance of each variable and the direction of its effect on investment in equation (3) do not follow except by analogy from the signs of the corresponding partial derivatives in the microeconomic demand functions discussed in Chapter 2. However, the most interesting explanatory variables are those that have been seen to have a logical causal relation to investment decisions at the microeconomic level. So the variables tested are those that have a logical relation to the investment decision process. The hypotheses here about the direction of the effect of each explanatory variable on the level of investment will also be the same as the hypothesis about the sign of the corresponding effect for individual families.

Current Income, Y_{Dt}, is expected to have a positive effect on all components of investment in higher education, assuming that educational capital is a normal good. The effect is expected to be significant because borrowing against expected income is inhibited by lenders risk (in the absence of collateral), by borrowers risk (based on the uncertainty of students about their capacities), and by the fact that parents rather than students bear most of the out-of-pocket costs. The income elasticity of investment demand is expected to be high because of the presence of a modified accelerator or capital stock adjustment effect similar to that that operates with consumer durable goods.

Income Expected from College Training, Y^e_{Bt}, is also hypothesized to have a positive and significant effect on new gross investment. It is the absolute difference in expected income that matters as a continuing inducement to investment. So this variable is measured in the mean annual income of persons who have completed four years of college or more, less the mean annual income of high school graduates, expressed as are all other non-demographic variables in constant (1958) dollars. To obtain the *fastest* growth in output, families must invest their resources where *relative* rates of return are highest. But even though rates of return should diminish, a positive absolute difference in expected income, net of investment costs, would stand as a continuing inducement to invest. The hypothesis about Y^e_{Bt} contains also an implicit hypothesis about how expectations can be measured, to the effect that expectations about the *future* are formed solely on the basis of observation by families of *current* income differentials. But using this measurement hypothesis (common to most tests of the effects of expected incomes and prices), and expecting some multicollinearity with current income, a positive effect of income and employment expected from college training independent of that of current income is hypothesized. Rojer Freeman (1971) studies only this effect in isolation and finds it to be very important.

New Knowledge, ρ, creating new opportunities for investment in human capital, is expected to have a significant and positive effect on investment. The new knowledge most pertinent here is primarily that created by basic research in all fields. Once new technology is embodied in new machine designs, most of the learning by the labor force probably occurs on the job through learning by doing Arrow (1962). But new knowledge can make some human capital obsolete, even when it merely extends existing principles, while also creating new opportunities for graduate and undergraduate students to acquire the proper training. New content in higher education made necessary by the development of modern medical techniques, economic stabilization methods, and the invention of the computer offer some examples. This source of shifts in the investment demand function (or marginal efficiency of human capital schedule) is difficult to measure. But as a first approximation, a slow and presumably fairly steady accretion of new knowledge can be represented by extracting from the residuals any remaining time trend using a first order autoregressive transformation of the form:

$$u_t = \rho u_{t-1} + \varepsilon_t$$

In Chapter 6 the possibility of using investment in research done at universities as a second approximation for the creation of new basic knowledge, with this in turn made endogenous, will be explored.

Psychological Stocks of Tastes, S_{Pt-1}, are hypothesized to have direct positive effects on new investment in higher education by the family. These family tastes are measured as the number of persons aged 35 to 64 (who are therefore in the age bracket of the parents of college students) who have completed four or more years of college. This transmission of information by the parents to children is a "pull" factor; Harvey Brazier and Martin David (1962) found the educational attainment of the head of the household to be the single most important factor influencing the educational attainment of the child. The interdependence of tastes, or demonstration effect within the family is normally fairly strong, and the direction of the *direct* effects of taste changes can be determined Basman (1956). But a serious problem arises in the multicollinearity that exists between S_{pt-1} and the existing stock of educational capital (S_{Et-1}) in a stock adjustment model.

Existing Stocks of Higher Education Capital, $P_E S_{Et-1}$, can be expected to have a negative effect on gross new investment as desired (equilibrium) capital stock levels are approached. Extensive work was required to prepare a continuous data series for the stock of higher educational capital valued at the original real cost of the resources invested. Measures of the portion of the stock created by higher education, as well as of the total stock of educational capital, both valued in constant (1958) dollars, are presented in Appendix B. The procedures used in preparing the estimates are similar to those used by T. W. Schultz (1971), p. 129, when he prepared estimates for his 1940 and 1957 benchwork years and are described in detail in Appendix B. There is a problem in that the stock of higher educational capital possessed by all households in the society includes that of the parents, conceptually appropriate in a family decision unit stock adjustment model, but statistically troublesome in that it overlaps with parents education used as a measure of the relevant stock of tastes. Another problem is that replacement investment represented by δS_{Et-1} loans as such a large, positive, and indistinguishable fraction of the total that it is likely to swamp the negative effect from existing stocks on net investment due to cyclical stock adjustment effects and to diminishing returns.

Young Adults Age 18-26, C_{18-26}, as a percent of the population are expected to have a significant positive effect on investment by families in higher education. From one point of view, eligibles are necessary for there to be investment opportunities and expected future returns; from another but closely related viewpoint the presence of eligibles shifts the family's taste structure. On either count the effect on new investment can be expected to be positive. Campbell and Siegel regard C_{18-24} as significant by using it to deflate enrollment data in their time series regressions Campbell and Siegel (1967), the Hoenock (1968), and Massachusetts Board of Higher Education (19), studies use the same procedure in analyzing enrollments in cross section data, and it is a reasonable conclusion that the slightly larger age span used here to include graduate education has significant effect on investment by families over time.

Own-Price Effects, p_{it}, may be positive or negative, depending on the elasticity of demand when expenditure ($p_{it}\ q_{it}$) is the dependent variable as in the investment model. However in the enrollment model, results for which are presented in section IV below, enrollment (q_{it}) is the dependent variable in the functions that deal with derived demands for inputs used in the production by families of embodied educational capital. The own-price effect can be expected to be negative in this case, by analogy with the Slutsky theorem as it applies to individual decision units. Even though enrollment is still an approximation for the quantity of education (it ignores quality) the enrollment model estimated by simultaneous equation methods offers a clearer test of a negative own-price coefficient hypothesis.

Cross-Price Effects, p_{jt} will be expected to be positive for substitutes. Where for example the defendent variable is education obtained at public institutions (or some component of that education), p_{jt} refers to the corresponding real price at private institutions which if increased could be expected to have a positive effect on demands for public education. p_{jt} is a relative price in the sense that the own-price in the regression equation is essentially held constant statistically at its mean. All prices also are expressed in real terms, or relative to current consumption price levels, by dividing them by the personal consumption expenditure implicit deflator.

Families also substitute between current and future consumption. Investment in higher education involves a choice in favor of the future, with future returns, as does investment in housing, consumer investment in durable goods, investment in health, or saving by accumulating financial assets. A higher long-term interest rate reflects a higher "price" to the family for borrowing or use of its own savings to invest in education. So interest rates, measured as the real interest rate on long-term first mortgages, are hypothesized to have a negative effect on investment in higher education by families. If asset portfolio equilibrium considerations are more relevant for higher income families who pay higher tuition, room, and board at /private institutions, then interest rates could be expected to be more significant for families investing there than for investment at public institutions.

III. EMPIRICAL RESULTS; INVESTMENT IN HIGHER EDUCATION

The basic investment function for household investment in higher education given by equation (3) has been estimated with all variables included as shown in Table 1. The net regression coefficients and t statistics therefore offer one simultaneous test of all hypotheses discussed for the 1946-1968 period. After the wage rate foregone ($\bar{w}_t$) is tried in Table 2, the variables that infrequently reach the .05 level of significance and have high multicollinearity with other significant variables are dropped from all equations. The re-estimated equations are as shown in Table 3. The latter after some examination of the stability of the parameters are used for prediction tests in section V.

Investment in Higher Education by Families

Total investment by families over time at public institutions as shown by equation (4) (the first line in Table 1. It is determined primarily by current disposable personal income, Y_{Dt}, and the number of college-age young adults as a percent of the population, C_{18-26}, and an index of the average price of tuition, fees, room, and board per student at public institutions, p_{it}. Other explanatory variables are not significant at the .05 level.

Total investment at private institutions, equation (5) is also influenced by current income Y_{Dt} as hypothesized, but also by the absolute real returns expected from a bachelors degree Y^e_{Bt} in place of the size of the college age population. Real interest rates r_t significantly deter investment in education at private institutions, but not at public institutions in (4), (6), and (8). The positive relation to all components of

Table 1. Investment by Families in Higher Education, 1946-1968
(t-statistic in parentheses below coefficient: significant coefficients (.05 level) underlined)

Investment (Dependent variable)	Current income Y_{Dt}	Expected returns Y^e_{Bt}	College-age Pop. C_{18-26}	Interest rates r_t	Parents' tastes S_{Pt-1}	Stock of HE capital $P_E S_{Et-1}$	Price at Pvt.(Pub.) p_{jt}	Own-price p_{it}	ρ
(4) Total investment, public	.043	.793	49,343	17.73	-.473	12.05	2,810	-8,063	-.34
R^2 = .998	(6.54)	(1.88)	(4.68)	(.08)	(-.72)	(1.98)	(1.32)	(-2.16)	
D.W. = 2.29									
(5) Total investment, private	.018	.948	-7,021	-696.33	-1.00	1.88	-8,180	9,470	-.35
R^2 = .997	(4.83)	(4.04)	(-1.19)	(-5.70)	(-2.73)	(.55)	(-3.92)	(7.96)	
D.W. = 2.34									
(6) Tuition, fees, public	.004	-.026	5,366	78.30	.003	-.531	1,494	-2,022	-.71
R^2 = .999	(14.52)	(-1.91)	(16.88)	(6.28)	(.07)	(-1.37)	(6.06)	(-6.75)	
D.W. = 2.21									
(7) Tuition, fees, private	.003	.035	4,825	-64.22	-.106	.244	-903	2,131	-.13
R^2 = .997	(2.81)	(.69)	(4.47)	(-1.68)	(-.82)	(.19)	(-.97)	(2.67)	
D.W. = 2.17									
(8) Room and board, public	.004	-.116	22,352	186.46	.307	2.55	88.53	1,439	-.03
R^2 = .996	(2.05)	(-.92)	(13.2)	(3.27)	([illegible].58)	(1.07)	(.06)	(.72)	
D.W. = 2.32									
(9) Room and board, private	-.001	.028	7,221	7.71	.251	-.554	-3,158.98	5,216	.07
R^2 = .986	(-1.08)	(.29)	(5.65)	(.18)	(1.85)	(-.33)	(-2.24)	(4.69)	
D.W. = 1.73									

investment at public institutions suggests instead that higher interest rates have not significantly deterred current out-of-pocket expenditures there. There is a negative cross price effect on investment at private institutions from increases in price at public institutions that was not expected, but judgment on tests of old price effects is best deferred until the simultaneous equation estimates of the enrollment model are examined. The positive own-price effect in (5) may suggest, tentatively, an inelastic demand or a demand affected by rationing through selective admissions.

Tuition and fee and room and board components of total investment at public and private institutions are considered in equations (6) - (9) of Table 1 with results very similar to those just discussed. The component reflecting excess foregone earnings (measured as manufacturing wage rates times college enrollments, adjusted for unemployment and for the length of the school year, and net of room and board costs) constitutes about one-third of total investment by households but is not analyzed separately in Tables 1-3. The wage rate that can be earned, however, is not only an imputed cost of the time spent, but also an inducement to quit school. It is tried in place of S_{pt-1} in Table 1 (which is seldom significant and highly correlated with S_{Et-1} ($r = .99$)), but the results with this foregone earnings rate are insignificant as shown in Table 2.[3] The results for the tuition and fee and room and board equations in both tables are generally consistent with the results for total investment at public and private institutions in Table 1. Expected returns Y^{e}_{Bt} in (11) is less significant when the foregone wage $\bar{w}_t$ is introduced, but the Cochrane-Orcutt technique used for estimating a first order autoregressive

Table 2. Investment by Families in Higher Education, 1946-1968
(t-statistic in parentheses below coefficient; significant coefficients are underlined.)

Investment (Dependent variable)	Current income Y_{Dt}	Expected returns Y^e_{Bt}	College-age Pop. C_{18-26}	Interest rates r_t	Foregone wage $\bar{w}_t$	Stock of HE capital $P_E S_{Et-1}$	Price at Pvt. (Pub.) p_{jt}	Own-price p_{it}	ρ
(10) Total investment, public $R^2 = .998$ D.W. = 2.29	.042 (5.74)	.636 (1.69)	53,761 (6.09)	106.1 (.57)	-.268 (-.23)	9.3 (2.02)	1,412 (.98)	-7,096 (-1.94)	-.34
(11) Total investment, private $R^2 = .998$ D.W. = 2.55	-.001 (-.34)	-.066 (-.28)	18,708 (3.75)	-131.58 (-1.26)	1.89 (4.00)	-1.30 (-.55)	-.471 (-3.22)	9,763 (9.97)	.35 did not converge in 20 iterations
(12) Tuition, fees, public $R^2 = .999$ D.W. = 2.13	.004 (11.82)	-.022 (-2.03)	5,024 (18.57)	68.90 (6.40)	-.110 (-1.51)	-.358 (-1.31)	1,356 (5.69)	-1,898 (-6.60)	-.68
(13) Tuition, fees, private $R^2 = .997$ D.W. = 2.21	.002 (1.39)	.008 (.19)	6,209 (6.41)	-35.04 (-1.07)	.213 (.95)	-.636 (-.67)	-935.3 (-1.02)	2,052 (2.70)	-.17
(14) Room and board, public $R^2 = .997$ D.W. = 2.24	.008 (3.55)	.005 (.04)	17,640 (9.37)	93.19 (1.60)	-.748 (-1.98)	4.96 (2.98)	513.5 (.36)	1,174 (.61)	-.10
(15) Room and board, private $R^2 = .982$ D.W. = 1.72	-.0001 (-.05)	.093 (.92)	5,213 (3.25)	-31.7 (-.64)	-.151 (-.50)	1.39 (1.00)	-3,073 (-1.97)	5,906 (5.06)	.01

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scheme used as a correction for autocorrelation in the residuals did not converge in 20 iterations.

In Table 3 estimates are presented for the same total investment, tuition and fee, and room and board equations after the variables that are least significant are dropped from all equations. Those dropped include the psychological stock of tastes S_{Pt-1} measured by using the parents' education, and the household stock of higher education measured at original cost $P_E S_{Et-1}$ which are highly correlated with one another (r = .994) as well as with current income (r = .989 and .993 respectively). Expected earnings Y^e_{Bt} is generally less significant in Tables 1 and 2 than is current real disposable income Y_{Dt}, with which it is positively and highly correlated (r = .91). So even though Y^e_{Bt} can be expected to represent a somewhat different effect, it is omitted for now from Tables 3 and 4 with Y_{Dt} acting as a partial proxy. The weekly earnings foregone (adjusted for unemployment) $\overline{W}_2$ was not significant in Table 2, although it does have the expected negative effect on investment in those instances where it reaches the .10 significance level after an appropriate correction for autocorrelated disturbances. This suggests some positive effect on school-leaving of strong labor markets that do not require formal training. The effect is consistent with a response by families to alternative rates of return, and with similar results obtained recently for household investment in primary and secondary education (Popp, 1972, Table 5), but the effect does not appear to be a very strong one.

The results in Tables 3 and 4 reveal that current income Y_{Dt} and college-age young adults as a percent of the population C_{18-26} are both consistently positive and significant as hypothesized. (The last equation

Table 3. Investment by Families in Higher Education 1946-1968
(t-statistic in parentheses below coefficient; significant coefficients are underlined)

Investment (Dependent variable)	Current income Y_{Dt}	College-age Pop. C_{18-26}	Interest rates r_t	Own-price P_{jt}	Constant term	ρ
(16) Total investment, public R^2 = .997 D.W. = 1.84	.045 (12.95)	66,829 (10.57)	469.8 (3.29)	-70.07 (-.03)	-20,228 (-9.60)	-.11
(17) Total investment, private R^2 = .995 D.W. = 1.84	.003 (1.71)	19,592 (8.95)	-187.5 (-1.94)	6,597 (8.04)	-5,370 (-8.61)	-.04
(18) Tuition, fees, public R^2 = .997 D.W. = 2.13	.004 (16.52)	5,800 (20.86)	45.84 (2.94)	-182 (-1.58)	-1,858 (-21.32)	-.29
(19) Tuition fees, private R^2 = .997 D.W. = 2.24	.003 (4.51)	5,817 (11.02)	-55.8 (-2.19)	1,247 (7.73)	-1,643 (-9.10)	-.07
(20) Room and board, public R^2 = .995 D.W. = 1.65	.009 (9.37)	19,373 (14.50)	152.6 (3.05)	2,536 (2.84)	-7,262 (-10.29)	-.07
(21) Room and board, private R^2 = .982 D.W. = 1.42	.0003 (-.41)	6,458 (7.10)	13.5 (.36)	4,103 (6.99)	-3,866 (-8.77)	.02

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Table 4. Investment by Families in Higher Education, 1929-1940, 1946-1968
(t-statistic in parentheses below coefficient; significant coefficients are underlined)

Investment (Dependent variable)	Current income Y_{Dt}	College-age Pop. C_{18-26}	Interest rates r_t	Own-price p_{it}	Constant term	ρ
(22) Total investment, public R^2 = .995 D.W. = 2.02	.048 (30.21)	56,324 (13.27)	375.18 (6.88)	-1,510 (-1.59)	-17,821 (-2.53)	-.005
(23) Total investment private R^2 = .993 D.W. = 1.59	.015 (6.05)	5,051 (.90)	-23.3 (-.34)	1,602 (1.55)	-3,227 (-3.83)	.67
(24) Tuition, fees, public R^2 = .994 D.W. = 2.05	.004 (32.30)	5,694 (17.30)	39.33 (11.25)	-6.10 (-.12)	-1,854 (-37.4)	-.13
(25) Tuition, fees, private R^2 = .995 D.W. = 1.98	.003 (4.40)	4,802 (3.95)	13.35 (.88)	1,023 (4.74)	-1,903 (-9.54)	.60
(26) Room and board, public R^2 = .992 D.W. = 1.91	.011 (23.28)	15,304 (10.18)	81.51 (4.75)	261 (.63)	-4,882 (-16.18)	.18
(27) Room and board, private R^2 = .984 D.W. = 1.32	.002 (2.37)	1,567 (.55)	-9.48 (-.48)	230 (.77)	533 (.96)	.96

in each table dealing with room and board expenditures at private institutions has residuals dominated by outliers (21) and later by unusually large autocorrelation (27), so the results for that equation are less dependable and will not be emphasized.) The parameters obtained for the 1946-1968 years in Table 3 for those variables are quite stable and of the same order of magnitude as those obtained for the entire period including the pre-war years in Table 4, excepting only those for total investment at private institutions which include the troublesome room and board component.

Interest rates have a net relation that suggests that they could have been a significant deterrent to investment at private institutions in the post-war years (see (17), (19). But the effect is not significant when the pre-war years are included ((23), (25)), and there is a distinctly positive association between long-term interest rates and investment at public institutions in all equations (i.e. (16), (18), (20), (22), (24), and (26). There may be a common cause of higher interest rates and higher expenditures for college such as the population bulge; it affects residential construction, demands for long term credit, and college enrollments. It may be concluded that interest rates have not been a strong deterrent to this form of human capital investment, with the possible exception of some effect on expenditures by families for tuition and fees at private institutions.

The hypothesis concerning the first order autoregressive coefficient ρ was that the creation of new knowledge through research would cause some obsolescence of existing skills and simultaneously create new investment opportunities, both stimulating new investment in human capital through an effect to be found in the residuals. If such an effect behaves like an independent trend, there is no evidence of it to be found in the postwar period, however, because ρ is not large and is also not significantly positive in any of the equations in Table 3. ρ is larger and significantly positive when the pre-war period is included in Table 4, but then at private institutions only. It is large and significant for public and private institutions alike for this 1929-1968 period taken as a whole when the functional form is switched to linearity in the logs (see Table 6, equations (32) - (35)). In principle, any effect from obsolescence of existing human capital should have a separate effect through δ, increasing the coefficient of the own-stock term $P_E S_{Et-1}$ from the negative toward the positive direction in Tables 1 and 2, but both the obsolescence and new-opportunity effectsshould be collected in the residuals and show up in ρ in Tables 3-5.

Since a correction for first order autoregression in the residuals has been made in Tables 1-5 (by the Cochrane - Orcutt iterative technique) however, there is no distortion of the results, at least from first order autoregression in the residuals. Multicollinearity among all the explanatory variables is low as shown by Table 5, except for that between income Y_{Dt} and own-price P_{it}. The price index for tuition and fees at private institutions and disposable personal income are particularly highly correlated. The possibility of simultaneous equation bias affecting the price terms will be considered further in connection with the restricted three stage least squares estimates of the enrollment version of the model.

Income elasticities of investment by families in higher education are consistently higher than unity for investment at public institutions as shown

Table 5. Zero Order Correlation Matrix; Independent Variables Used In Tables 3, 4, and 6

	Y_{Dt}	C_{18-26}	r_t
1946-1968: (Table 3)			
C_{18-26}	-.12		
r_t	.15	-.34	
p_{it}	.96 to .98	-.33 to -.17	.20 to .27
1929-1968: (Table 4)			
C_{18-26}	-.73		
r_t	-.78	.78	
p_{it}	-.19 to .87	-.47 to .48	-.40 to .72
1946-1968: (Table 6)	$\ln Y_{Dt}$	$\ln C_{18-26}$	$\ln r_t$
$\ln C_{18-26}$	-.22		
$\ln r_t$	.18	-.35	
$\ln p_{it}$	.97 to .98	-.37 to -.23	.20 to .28

Table 6. Elasticities of Investment by Families in Higher Education; 1946-68 and 1929-40, 1946-68
(Data in natural logs; t-statistic in parentheses; significant coefficients are underlined.)

Investment (Dependent variable)	Current income Y_{Dt}	College-age Pop. C_{18-26}	Interest rate r_t	Own-price p_{it}	ρ	$R^2_{u_t}$, (ρ=0) SE_{u_t}	$R^2_{\varepsilon t}$ (after ρ) SE_{ε_t}
(28) Total investment, public ('46-68) D.W. = 1.05	2.91 (6.27)	.72 (2.20)	.92 (2.28)	-.73 (-.85)	.23	.966 .112	.985 .075
(29) Total investment, private ('46-68) D.W. = 1.93	.01 (.06)	.42 (6.02)	-.20 (-1.35)	2.00 (9.17)	.04	.950 .086	.995 .026
(30) Tuition and fees, public ('46-68) D.W. = 1.71	1.76 (7.00)	.30 (2.72)	-.13 (-.50)	1.85 (5.72)	-.03	.989 .082	.997 .044
(31) Tuition and fees, private ('46-68) D.W. = 2.23	.44 (1.88)	.07 (.64)	-.26 (-1.44)	1.82 (9.10)	.31	.987 .072	.998 .028
(32) Total investment, public ('29-68) D.W. = 1.81	2.39 (10.35)	.34 (1.12)	.16 (.55)	.27 (.68)	.45	.988 .108	.993 .085
(33) Total investment, private ('29-68) D.W. = 1.64	.98 (4.33)	-.05 (-.24)	-.66 (-2.76)	.80 (2.73)	.53	.992 .066	.994 .056
(34) Tuition and fees, public ('29-68) D.W. = 1.64	1.33 (4.10)	-.19 (-.48)	-.08 (-.20)	2.22 (5.16)	.65	.984 .109	.990 .085
(35) Tuition and fees, private ('29-68) D.W. = 1.60	.34 (1.52)	-.28 (-1.30)	-.22 (-1.08)	1.91 (9.49)	.62	.979 .102	.995 .048

in Table 6. The pattern of high income elasticities for total investment, ranging from 2.4 for the entire 1929-1968 period to 2.9 for the postwar period taken alone suggests a rather large accelerator effect for investment in stocks of educational capital when income changes, a matter of considerable importance to short run fluctuations in family educational investment as well as to long run growth of investment-demand.

The income elasticities of tuition and fee components (1.3 to 1.7 for the comparable periods) and room and board components of total investment (1.2 to 1.8 although not shown separately on Table 6) are some lower. The income elasticity of investment-demand at private institutions is much lower, although private schools have raised tuition and room and board charges more rapidly than public institutions. As demands are shifting outward, this could have the effect of capturing more of the investment from the growing demand in the coefficient of the own-price term (see (29), (31), (33), and (35). For the 1929-1946-1968 years, for example, the index on a 1958 = 1.00 base for tuition and fees at private institutions rose from .52 to .70 to 1.52, a three-fold increase, whereas it approximately doubled from .69 to .83 to 1.30 at public institutions during the same period. A consistent pattern of income elasticities can be found in microeconomic cross section data. There net income elasticities of expenditure on tuition and fees are greater than unity overall McMahon and Wagner (1973), Table 5, but lower in a sample of families using predominately private institutions ibid., (Table 4) where tuition and fees partially reflecting ability to pay tend to be raised to high income families.

Elasticities of investment expenditure in response to changes in the college-age population are low, falling between .3 and .7 for total investment at public institutions (see (32) and (28)) and between 0 and .4 for investment at private institutions (see (33) and (29)). The response of investment by families in higher education to changes in population structure is of interest both in appraising the effects on educational institutions of the passing on through of the young adults born during the postwar spurt in birth rates, and in appraising the effects on educational investment of zero population grwoth. The percent of young adults ages 18-26 in the population fell from 15.2 percent in 1946 to a low of 10.9 percent in 1960, but then jumped to 12.8 percent in 1965 when the first group of 18 year olds born postwar reached college age. The climb in this 18-26 age group then continued, returning to a 15.8 percent peak in 1972 where it flattened out. It will stay at that level until 1980 while the postwar bulge of college eligibles continues to pass out of the college-age bracket. The approximately 50 percent increase in this variable from 1960 to 1972 has been associated with about a 35 percent increase total real investment by families at public institutions, or about one seventh of the 250 percent real increase occurring at those institutions during this rapid growth period.

Table 7. Demand by Families and Supply by Institutions of Higher Education, 1946-1968
Restricted Three Stage Least Squares Estimates of Structural Enrollment Model
(t-statistic in parentheses below coefficients; significant coefficients are underlined)

Endogenous variables

Public institutions

Demand:

$$(36)\quad q_{Pub.} = \underset{(2.02)}{\underline{.0102}}\, Y_D + \underset{(.18)}{.0301}\, Y_B^e + \underset{(5.24)}{\underline{24080}}\, C_{18-26} + \underset{(1.71)}{114}\, r + \underset{(2.01)}{\underline{.510}}\, S_{Pt-1} + \underset{(.20)}{.701}\, S_{Et-1} - \underset{(-.85)}{4.93}\, p_{\substack{T+F\\ Pub.}} - \underset{(-9.10)}{\underline{6355.2}}$$

Supply:

$$(37)\quad p_{Pub.} = \underset{(-2.56)}{\underline{-.0823}}\, q_{Pub.} + \underset{(4.34)}{\underline{9.08}}\, w - \underset{(-4.38)}{\underline{1.00}}\, (p_{S+L} + p_F + p_G)_{Pub.} + \underset{(2.37)}{\underline{221.6}}$$

Private institutions

Demand:

$$(38)\quad q_{Pvt.} = \underset{(-.20)}{-.0005}\, Y_D - \underset{(.08)}{.0073}\, Y_B^e + \underset{(5.93)}{\underline{10273}}\, C_{18-26} + \underset{(1.51)}{68}\, r + \underset{(3.51)}{\underline{.629}}\, S_{Pt-1} + \underset{(-2.97)}{\underline{-6.05}}\, S_{Et-1} + \underset{(.133)}{.129}\, p_{\substack{T+F\\ Pvt.}} \underset{(-3.61)}{\underline{-1813.2}}$$

Supply:

$$(39)\quad p_{Pvt.} = \underset{(3.06)}{\underline{+.2905}}\, q_{Pvt.} + \underset{(8.37)}{\underline{7.71}}\, w \;\underset{(-3.51)}{\underline{-1.00}}\, (p_{S+L} + p_F + p_G)_{Pvt.} - \underset{(-4.91)}{\underline{256.4}}$$

Public institutions

Demand:

$$(40)\quad q_{Pub.} = \underset{(2.66)}{\underline{.0124}}\, Y_D + \underset{(4.83)}{\underline{21982}}\, C_{18-26} + \underset{(2.48)}{\underline{.471}}\, S_{Pt-1} \underset{(-1.28)}{-6.64}\, p_{\substack{T+F\\ Pub.}} \underset{(-11.65)}{\underline{-5526.9}}$$

Supply:

$$(41)\quad p_{Pub.} = \underset{(-2.50)}{\underline{-.0802}}\, q_{Pub.} + \underset{(4.31)}{\underline{8.99}}\, w \;\underset{(-4.40)}{\underline{-1.00}}\, (p_{S+L} + p_F + p_G)_{Pub.} + \underset{(2.43)}{\underline{226.0}}$$

Private institutions

Demand:

$$(42)\quad q_{Pvt.} = \underset{(7.13)}{\underline{9697}}\, C_{18-26} + \underset{(4.22)}{\underline{.605}}\, S_{Pt-1} - \underset{(-3.24)}{\underline{6.59}}\, S_{Et-1} + \underset{(.371)}{.248}\, p_{\substack{T+F\\ Pvt.}} \underset{(-4.05)}{\underline{-1378.6}}$$

Supply:

$$(43)\quad p_{Pvt.} = \underset{(3.05)}{\underline{.2912}}\, q_{Pvt.} + \underset{(8.36)}{\underline{7.70}}\, w_t - \underset{(-3.51)}{\underline{1.00}}\, (p_{S+L} + p_F + p_G)_{Pvt.} \underset{(-4.93)}{\underline{-256.6}}$$

Chapter 4

State and Local Investment in Higher Education, 1929-1980

Public support for higher education which has come primarily from state and local governments was encouraged at on early date by the Morrill Land Grant Act of 1862 providing a basis for the establishment of state institutions. Basically its role is one of supplemental assistance to the production of educational capital by households. Its size and relative importance continues to be second only to the investment in human resources made by individual families themselves through their expenditures on tuition, fees, room, board, and their investment of additional foregone earnings.

The main thrust of this state and local supplemental support has been toward extending higher education to a larger proportion of the population while broadening its scope to include vocational educational in agriculture, the mechanic arts, business, and more recently, in urban social services. Although other very important scientific and cultural developments have also been supported, a major state and local emphasis continues to be on the development of vocational skills. Even Christopher Jencks (1972) who stresses the limitations to the effectiveness of formal education, regards job competence as important to lifetime income. So there surely has been an effect in the direction of extending higher education to the middle classes, and extending the fruits of economic growth more widely in the population than might otherwise have been the case. Following the land grant act whole new fields and new curricula were created in areas like agriculture. Now if higher education is to be extended to the poor, there is an important need again for the creative development of workable new curricula if the experiment is to be successful.

The objective of this chapter is to test for and attempt to isolate the three or four most important determinants of state and local support. The potential significance of the income inelasticity of state and local tax revenues for example, is much debated, as is the effect of expected returns from education, the 1970 student demonstrations, and the condition of job markets. A public expenditure theory framework is needed to screen out those variables that do not have a logical relation to expenditure levels and to help resolve the familiar dilemmas arising out of multicollinearity. Such a framework is provided in Part I, after which the investment and supplemental-enrollment versions of the model are tested in an exploratory vein in Parts II and III. Finally, those parameters that appear to be relatively stable are used in some conditional simulations extending to 1980.

State and local investment in human capital formation made through publically and privately controlled institutions is analyzed separately parallel to the similar separation of investment by families in Chapter 3. However, in addition to these totals, the component current expenditures at universities, four year institutions, and two year junior colleges are considered in each case. Universities and four year institutions receive public support primarily from state governments, whereas public junior colleges which have expanded so rapidly in recent years draw a significant portion of their support from localities.

A few words of caution about two points perhaps are needed. First, the data aggregates expenditures by all state and local tax and expenditure decision making units, even though expenditures are disaggregated by type of educational institution. The results therefore must be interpreted with care; they will indicate which influences emerge as most important, but must be viewed as exploratory from the point of view of testing hypotheses about influences on the behavior of individual decision making units. Second, results do have an important bearing on economic policy, but predictive results should not be confused with those obtained from a normative model. Just as tax revenues at existing tax rates must be projected by economists and related to other events before the necessary changes in rates can be determined, so also it is fruitful to project expenditures based on past expenditure propensities for comparison with normative criteria in the formulation of state policy in institutions, boards of higher education, budget bureaus, and state legislations. Federal aid policies to be effective also need to be able to predict state and local patterns in the absence of newly contemplated federal action.

I. PREDICTIVE PUBLIC EXPENDITURE THEORY

A brief look at trends in private and public support for higher education may help to put the analysis of influences on the level of state and local support that follows in better perspective.

Household, State and Local, and Federal Investment

The 1968 column in Table 1 indicates that state and local investment in higher education at public institutions is about one third of total investment made at these institutions by families. It is about equal to the out-of-pocket expenditures there by families, and these patterns were roughly the the same in 1946 and in 1929. When expenditure at private institutions is included, total state and local investment is less than one fourth of total investment by households, and slightly over one half of family out-of-pocket expenditures.

Table 1. Family State and Local, and Federal Support of Higher Education, Selected Years

	1929 millions current $	1946 millions current $	1968 millions current $	Real growth rate per year 1946 to 1968 in constant dollars
Public institutions:				
1. Family	352.3	1,210.5	16,258.4	9.9%
2. Tuition and fees	27.3	69.0	1,399.0	12.0%
3. Room and board	153.5	425.1	4,323.7	8.5%
4. Excess foregone earnings (beyond room and board)	171.5	716.4	10,535.7	10.4%
5. State and local	125.9	307.2	5,421.1	11.3%
6. Federal aid (to education)	14.7	135.9	552.1	4.1%
7. Gifts and endowment income	5.9	22.0	270.3	9.5%
Private institutions:				
8. Family	456.3	1,319.2	8,193.8	6.1%
9. Tuition and fees	110.0	190.4	2,431.0	9.7%
10. Room and board	210.7	503.6	1,913.5	3.8%
11. Excess foregone earnings	135.6	625.2	3,849.3	6.1%
12. State and local	7.3	16.3	130.3	7.3%
13. Federal aid (to education)	1.1	133.7	204.5	-.3%
14. Gifts and endowment income	69.6	150.7	1,061.5	6.7%

*1946 and 1968 figures are first deflated by the Personal Consumption Expenditures deflator, 1958 = 100.

Sources of Data: Lines 2, 5-7, 9, 12-14 U.S. Office of Education Financial Statistics for Institutions of Higher Education, 1968 Table 3, pp. 12-13 and corresponding tables in earlier Biennial Surveys; lines 3 and 10 multiply enrollment from the same source by average room and board charges at public and at private institutions from West, Farrell, and Blakeslee (1964) and National Center for Educational Statistic (1970). Lines 4 and 11 multiply these enrollments by the product of average hourly earnings in manufacturing excluding overtime, the average weekly hours of work (both from the Statistical Abstract), 25 weeks of work foregone by the student, and the employment rate in the civilian labor force from the Council of Economic Advisors (1971).

At private institutions however, state and local government support is replaced by gift and endowment income which provides a similar subsidy to families with children in college. But the much lower postwar annual growth rate of gift and endowment income has diminished its relative size to only about 20 percent of the state and local aid provided to public institutions. This has operated to force the private institutions toward the smaller, higher family income segment of the college market. Until the 1972 federal Higher Education Act provisions for aid to families based on need are more completely funded, private institutions will remain at a serious competitive disadvantage in educating significant numbers of students from lower income families.

State and local investment has been about ten times the size of federal investment in human capital formation at public institutions. Federal investment in higher education at private institutions has been small, but relatively more important than that of the states. (See Appendix C for the development of data separating federal aid to education at higher educational institutions from contract research. The allocation of joint costs is somewhat arbitrary, of necessity, but is consistent over time.) It is revealing to see how slowly federal support of education at both public and private institutions has grown -- more slowly than any other source of support at either place. Full funding of the 1972 federal Higher Education Act will affect this growth rate, but it nevertheless leaves federal support smaller than that from states and localities.

Overall, and in summary, support by families through tuition and fees and support by state and local governments for educational capital formation may be seen in Table 1 to have grown more rapidly in real terms than any other sources of support at either public or private institutions in the postwar years. Total state and local support, as indicated by the $5,551 million total in Table 1 for 1968, goes overwhelmingly to the publically controlled institutions. It is second in size only to the support coming directly from families and is many times federal aid. The following sections seek to explain key influences determining the level of this important state and local supplementary support.

Public Expenditure Theory

To explain causal relations between relatively basic influences operating through the political-economic decision process and their effects on expenditures on higher education by state and local governments, a logical model is needed.

The model to be developed briefly in this section seeks to capture the essence, but not all of the detail, of the expenditure level determination process. In essence, the state will be regarded as a quasi-independent economic decision-making unit, influenced by the tastes of the electorate (and by members of the electorate who are organized into pressure groups) as well as by autonomous elements unique to the tastes of key public officials. These tastes are all assumed to be represented by a "democratic state preference function" which in turn is constrained by the total economic resources available to the society and the tax handles available at any given time. The resulting solution is a joint solution of tax and expenditure sides and leads to testable hypotheses.

The joint solution of the tax and expenditure sides goes back at least to the Magna Carta and to the evolution of legislative control over expenditure categories that evolved throughout the Gladstone ministry. The continuing evolution of budgeting has been discussed by Schultze (1968), Burkhead and Miner (1972), and others, and the relation to the underlying resource base by Musgrave (1969, Chapter 3), by Buchanan (1968), and by a rich public expenditure theory literature extending backward through history (e.g. Musgrave and Peacock (1958)). Further details of specific public expenditure models and their relevant constraints are discussed in Gramlick (1969), McMahon (1971), and other sources cited there.

State Preferences. A "democratic state preference function" will be assumed to exist that has the character of a well ordered utility function possessed by representative key elected officials such as the governor and/or key legislators. They act in making decisions on expenditure levels as agents for the electorate, or groups within the electorate, while simultaneously acting with a degree of autonomy.

This social preference function which in one sense is a descendent of the "social indifference curves" discussed within a welfare context by Samuelson (1956) may be assumed to reflect the perceptions by the public official of the tastes of the electorate, since if it seriously fails to do so the elected official is likely to being replaced at election time. In this event there would be a discrete shift in the ruling democratic state preference function. The tastes of the electorate for particular public goods (and separately the disutility of particular taxes), are revealed but imperfectly to the public official through the mail, opinion polls, lobbyists, past experience with voting patterns, demonstrations, newspaper editorials, hearing testimony, and other forms of communication.

For these communications to be effective it is an important and necessary condition that there be viable alternative candidates available to the electorate at regularly scheduled elections. In the case of expenditures on higher education, candidates for office would normally tend to match current policies with those in power when there is widespread agreement in the electorate, and to develop alternative expenditure policies if there is not. If it is assumed that the state governments are financed by use of a predetermined set of tax handles (such as the sales tax), the net incidence of the expected benefits and tax costs of an increment to expenditures on higher education would be known in an approximate way by legislators and key policy makers concerned with levels of funding. Although it is unlikely to be a purely economic calculation, some groups in the electorate normally can be expected to favor more and some less expenditure on higher education. Therefore a realistic opportunity exists for the opposition if the discrepancy between current expenditures and the preferences of most of the electorate becomes large, for they can develop the issue and enhance their chance of election.

This model of public expenditure decisions made by governmental units under conditions of representative democracy is more appropriate for analysis of the determinants of expenditure on higher education than are the two extreme polar cases of authoritarian dictatorship or of individualistic pure voting about which so much has been said in the public expenditure theory literature. Authoritarian state preference functions maintained with the aid of military power used to control the electoral process may be common in other parts of the world, but they are not accurate prototypes of U.S. state or federal governments or of most other governments in the western democracies. Similarly, individualized voting "for and against" earmarked tax-expenditure packages is an idealized model advanced by Buchanan (1968) and others that deals with a type of direct voting by citizens on expenditure levels that does not offer an empirically relevant model of the way expenditures on higher education are determined. Citizens instead vote for candidates who after election and in anticipation of future elections in turn decide on appropriations and taxes separately, operating under general fund budgeting procedures.

Specific objections for public investment in higher education can best be reconciled within the context of broader social goals (and later, of economic constraints) as they apply to that program. Therefore the democratic state preference function is first expressed in the most general, and simplest possible, terms as a means toward identifying the problem before relating this modified welfare function to subsidiary objectives. It is:

$$(1) \quad W_T = W\left[\sum_{k=1}^{m} g_{kt} Y_{kt} \right], \qquad t = T,\ldots,L$$

Y_k = real personal income of the k^{th} family, before taxes,

g_k = weights attached to the income of the k^{th} family, (or k^{th} income class in the income distribution),

T = the current period, and L = the end of the elected official's planning horizon, (so there are implicit rates of discount attaching to real incomes expected in future periods).

The responsible elected official is free to attach whatever weights he chooses to the real income and hence to the utility of the k individual families or income classes. A solution in welfare theory for the bliss point, of course, would require that these weights be assigned by an independent and omniscient ethical observer. But in practical political economy it is reasonable to assume that the weights are sufficient to retain the support of those groups on which the public official primarily depends for re-election. In addition to this, weights assigned both parties will be in the direction of a more egalitarian distribution than that that would appear if every dollar of income were given equal weight. For although votes are not distributed on a strictly one-man-one-vote basis, they are distributed more equally than are income dollars. It is not suggested that final public expenditure outcomes are egalitarian; only that they are more egalitarian than if there were only dollar votes.

This source of a bi-partisan incentive to extend the benefits of post-secondary education farther down in the income distribution than they would otherwise be extended has had an important impact on the size and character of public support. The Land Grant Act and related low tuition at public institutions have led to the extension of post-secondary education to the sons of middle income farmers and to the urban middle class. The support of junior colleges lowers effective room, board, and transportation costs and extends it further. And the provisions of the Higher Education Act of 1972 which lower the cost of student loans and of tuition to families based on financial need also operates in the same direction.

Before maximizing the function given by (1) subject to the society's total resource constraints, then minimizing disutility using (1) subject to tax handle constraints to obtain a logical framework of potential determinants of expenditure on higher education, a comment is needed about the relation of the simpler general objectives to specific higher educational objectives. The Rivlin Report (1969) sets out objectives of federal support typical of those often stated by state leaders in higher education. They are (ibid, pp. 3-4):

"1. Increasing the number and proportion of educated people
2. Increasing equality of opportunity for higher education
3. Improving the quality of higher education
4. Preserving diversity in higher education and advancing autonomy and academic freedom
5. Strengthening graduate education and institutional research and the public service capabilities of higher educational institutions
6. Encouraging the efficient use of resources in higher education."

Objectives 1-5 can be regarded as means to the attainment of the more ultimate end of larger and more equitably distributed current and future real family income that is given by (1). They are stated as unconstrained goals, (as is (1)), whereas objective 6 reasonably suggests that the maximum real return from higher education arising from pursuit of 1-5 is to be attained subject to economic constraints.

Resource and Tax-Handle Constraints. In the first stage of the public expenditure decision process, when appropriations for higher education are being considered, current and expected future utilities arising from higher education, other public goods, and private goods as given by the total "welfare" function (1) are constrained by the total resources available to the society. This total resource constraint is:

$$(2)\quad Y_T + \sum_{t=T+1}^{L} \frac{Y_t^{e}}{(1+r)^{t-T}} = \sum_{t=T}^{L} \left[p_{S+Lt}\, q_t + (p_{T+F} + p_G + p_F)_t\, q_t + \sum_{i=1}^{n} p_{it} q_{it} \right]$$

Y_T = aggregate real personal income in period T,

Y_t^e = expected future aggregate real personal income,

q_t = enrollment in higher educational institutions,

p_{S+Lt} = state and local subsidy per student (a shadow price to the state),

$(p_{T+F}+p_G+p_F)_t$ = tuition and fee, gift and endowment income, and average federal subsidy per student, taken here as predetermined,

q_{1t} = the quantity, and p_{it} = the price (or shadow price) of all other public (i=1,..h) and private (i=h+1,..,n) goods.

This says that current and expected future personal income up to the end of the state's planning horizon must equal all public and private expenditure in current and future periods. Initial assets are assumed equal to the discounted present value of terminal assets at the end of the planning horizon and subtracted from both sides to simplify the constraint.

Tax handles and limits on borrowing constrain further the resources available to the state government for higher education. Borrowing by the state and its localities against future income, Y_t^e above, is limited by most state constitutions. They now regard net new investment in human capital formation in legal terms as current expenditure rather than as part of the capital budget. The tax-handle and borrowing constraint is:

$$(3)\quad p_{S+Lt}q_t + p_{1t}q_{1t} = t_1 \sum_{i=h}^{n} p_{it}q_{it} + t_2\, Y_t + F_t + B_t + R_t$$

$p_{S+Lt}q_t$ = state (and local) expenditure for post-secondary education (subsidy per student times enrollment),

$p_{1t}q_{1t}$ = all other expenditures by the state (and its localities),

t_1 = a sales tax rate, a parameter but only in the short run,

t_2 = an average income tax rate, a parameter but only in the short run,

F_t = federal grants-in-aid to the state government, including federal grants to higher educational institutions,

B_t = state (and local) borrowing, a predetermined parameter,

R_t = all other revenue.

This says that total expenditure by the state government and its localities must equal total tax revenue plus federal grants-in-aid plus borrowing. When federal aid is accompanied by formulas or mandates of various types, it has additional net incentive effects on particular expenditures that augment the dollar-for-dollar revenue replacement effect on the tax side shown above.

State and Local Investment-Demand. The effective demand by the state for investment in higher education now can be derived.

To simplify the derivation, the production functions that use higher education to produce future income and utility flows in the preference function can be left implicit. This allows the state preference function to be re-written in terms of quantities of inputs as follows:

$$(4) \quad W_T = W(q_{it}, \alpha_{it}, g_{kt}) \qquad i = 1,..,m, \ t = T,..,L.$$

The q's refer to quantities of formal higher education and of other public and private goods. The α's are taste parameters; tastes for education and the related investment opportunities are hypothesized to be a function primarily of the presence in families of eligible young adults, expressed as a percentage of the population,eg C_{18-26}. The g's are the Gini coefficient income-distribution-type weights discussed above that are assigned by the public officials whose preferences are expressed by the democratic state preference function given by (4).

Investment demand is derived by maximizing the state preference function (4) subject to the resource and tax handle constraints (2) and (3). That is, differentiating (4) with respect to q_{it} subject to (2) with prices treated as parameters gives first order conditions that may be solved for total enrollment demand for the current period (q_T), which is illustrated as DD in Figure 1. Together with the full cost price p_T (as influenced by the longer run institution average costs, or supply-price) and predetermined federal,

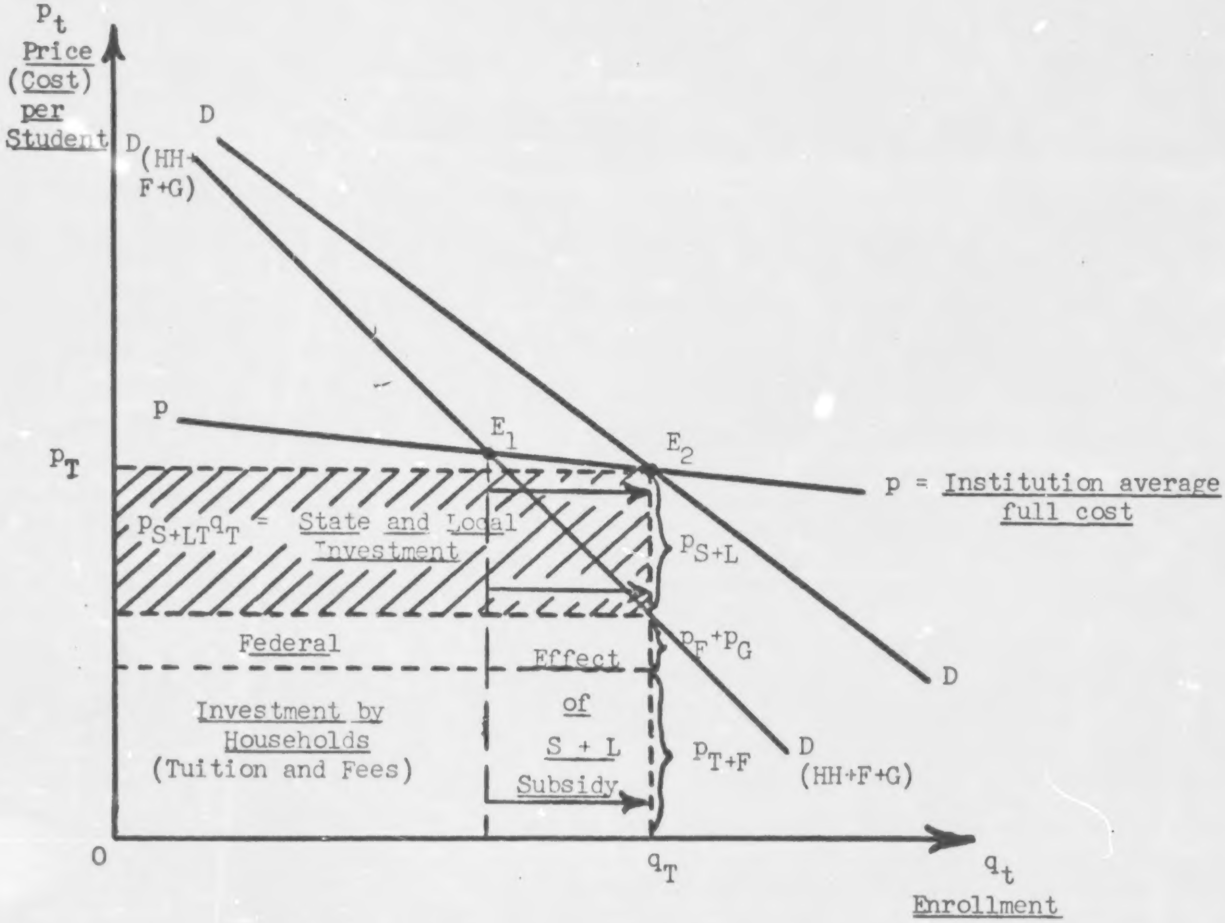
p_t
Price (Cost) per Student
D
D (HH+F+G)
p
E_1
E_2
p_T
p = Institution average full cost
$p_{S+LT}q_T$ = State and Local Investment
p_{S+L}
Federal
p_F+p_G
Effect of S + L Subsidy
Investment by Households (Tuition and Fees)
p_{T+F}
D
D (HH+F+G)
0
q_T
q_t
Enrollment

Figure 1: State and Local Effective Investment-Demand; Public Institutions Derived Demands For Formal Post-Secondary Education Used in the Production of Stocks of Human Capital

endowment fund, and household per student contributions ($p_F+p_G+p_{T+F}$), the state and local investment ($p_{S+Lt}q_t$) necessary to accomplish the objective can be determined. This investment is illustrated by the shaded area in figure 1. It implies a simultaneous solution for the most pertinent tax rate (e.g. t_1) under assumptions that other revenues in the tax function (3) have been predetermined[1], and that expenditures on higher education and tax policy are decided on under general fund budgeting procedures.

Short Term Dynamic Stock Adjustment Effects. Figure 1 illustrates the derived demand for formal education used as an input in the production of higher educational capital (S_{Et}). The resulting gross additions to society's depreciated stocks of higher educational capital are not likely to attain their equilibrium (in the sense of political optimum) levels immediately following changes in income, the numbers of young adults, or the other determinants of state decisions included above. Slow production and slow adjustment of large stocks are likely even though state and local subsidies have recently been directed more toward speeding up the adjustment process.

The first part of equation (5) brings out the fact that enrollment demand is a derived demand. It makes the implicit production function for the production of educational capital by households explicit by assuming for this purpose that it is of Cobb-Douglas form. The part of equation (5) that is in parentheses allows for the possibility of a partial adjustment of society's total stocks in any one year.

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[1] Joseph A. Pechman's (1972) "Distribution of Federal and State Income Taxes by Income Class" offers further evidence on the tax side of public sector egalitarian tendencies that also could be interpreted as deriving from the g_k income class weights in our democratic state preference function (4). To derive tax decisions, disutility from the preference function (4) would be minimized by trying alternative tax packages using the tax definition (3) at given expenditure levels.

$$(5)\ q_t = \frac{B_2}{B_1 + B_2} \frac{1}{P^{\gamma}_{S+Lt}} P_E \left(\theta'_{S+L} \left[S^*_{Et} - (1-\delta)\ S_{Et-1}\right]\right), \qquad t=T$$

To obtain investment demand (6), the above is multiplied by the price terms shown , and the process for producing educational capital is left implicit. The determinants of the demand for formal post-secondary education when stocks are in equilibrium that were derived above are then substituted for the desired stock of educational capital (S^*_{Et}).

State and Local Investment-Demand. The state and local investment-demand function that results is:

$$(6)\ I_{S+Lt} = p_{S+L}\, q_t = \Theta_{S+L}\, (Y_T,\ Y^e_{Bt},\ C_t\ g_{kt},\ p^{\gamma+1}_{S+Lt},\ \rho,\ (\delta-1) P_E S_{Et-1})$$

The effect of current income before taxes (Y_T) used as a measure of the state's total resource base on state (and local) investment is expected to be positive assuming that higher education is a normal good, and that there are not overwhelming economies of scale in its production. Under similar conditions, the sign of the coefficient of Y^e_{Bt} is also expected to be positive, assuming that the state preference function reflects an expectation that higher education will contribute positively to the economic growth of the state.

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[2] See Chapter 2, equations (1)-(3) and (13)-(15) for further discussion of the production of educational capital, and of stock adjustment toward S^*_{Et}, "Equilibrium" is interpreted there in ways appropriate to that context.

The number of young adults as a percent of the population (C_t), and the Gini coefficient of income inequality (g_{kt}), are "taste parameters in the democratic state preference function that come directly into the derived investment demand equation (Basman (1956)). Their signs are expected to be positive and negative respectively. Larger percentages of young adults means more children in the eligible age-range whose parents want the state to assist in opening up educational opportunities; this shifts total demand DD in figure 1 outward in relation to the other sources of demand, which at a given-full-cost price (p_T) will increase state and local expenditure. The egalitarian incentive in public expenditure is measured only imperfectly by the Gini coefficient (g_{kt}), but its sign could be expected to be negative if larger state effort is significantly stimulated by efforts to reduce inequality.

The cost to the state per student (p_{S+L}) can be expected to restrict state enrollment demand as suggested by the reciprocal $1/p_{S+L}^{\gamma}$ in (5) with $\gamma \geq 0$ by the Slutsky theorem. However, how total expenditure is affected depends upon the elasticity of the state's investment-demand, and if $-1 < \gamma < 0$ in (5) and (6) which is likely, then the effect of changes in unit cost to the state on state investment expenditure can be expected to be positive.

A stimulus to both net and gross investment in post-secondary educational capital can be expected from the new investment opportunities created by new knowledge and new basic research. Expected returns from the vintages of human capital embodying the new developments are hypothesized here as shifted in proportion to the trend in the real resources devoted to basic research. If the existence of such a stimulus to investment leaves a positive trend in the residuals, then ρ could be expected to be large enough to be significant and positive.

Finally, larger existing stocks of higher educational capital (S_{Et-1}) can be expected to act as a deterrent to further state and local investment in higher education, but only after other influences on gross investment have been fully taken into account. The obsolescence rate δ, for example,[3] may be increased by new research, which stimulates replacement investment and reduces the coefficient $(1-\delta)$ which weakens the deterrent effect of existing stocks. S. Rosen (1971) suggests that obsolescence rates of scientific knowledge are high (p. 28) but less than unity. If $(1-\delta)<1$, it is a reasonable hypothesis that large existing stocks, ceteris paribus, act to deter further state and local investment in higher education.

II. REGRESSION RESULTS FOR INVESTMENT BY STATE AND LOCAL GOVERNMENTS

The model developed above for a single state government is applied by analogy to the analysis of aggregate investment by all state governments as shown in Table 1. Each investment function contains exploratory tests of all hypotheses discussed above. The tests are for investment in human resources by states at all public and at all private institutions (in equation (10) and (14), at public and private universities (in equations (7) and (9)), at public and private four year colleges (in equations (8) and (11)), and for both state and local investment at two year junior colleges (in equations (9) and (13)).

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[3] Most "depreciation" arises as a result of retirement and death, which the measurement of S_{Et-1} has already attempted to take into account. See Appendix B.

The results in Table 1 for 1946-68 are compared to results for 1929-68 in Table 2 to appraise the stability of the parameters. The latter then are used for further tests and conditional predictions to 1980 in Table 3. Appendix A gives the sources of data for all variables.

Major Determinants of State and Local Investment in Higher Education. When the major effects suggested by the preceding analytical framework are tried simultaneously in Table 1, all variables that are significant at or near the .05 level in all equations have signs consistent with the hypotheses. The attempt made through multivariate analysis to hold the other variables constant statistically at their means provides a test that is more rigorous than simpler one or two variable analyses of the effect of each variable on each type of investment. The degree of consistency with the hypotheses is remarkable and encouraging.

One consistently important determinant of state and local real current expenditure on post-secondary education is current real personal income (Y_t). Its effect is always positive and significant at the .05 level. The marginal propensity to invest is .6 percent at public institutions, but considerably less than that at private institutions.

A second important determinant is the size of the potential college population (C_t). This is not too surprising since the fact that parents want educational opportunities for their children is frequently taken explicitly into account in state planning. The variable C_t is defined in this chapter, assuming that there is some advance state planning, as the proportion of the population ages 16-26, used in the university and total equations which include graduate programs, ages 16-22 in the four year college equations, and ages 16-20 in the two year junior college equations. The highly significant and positive coefficients are consistent with the hypothesis in all

Table I. Investment by State and Local Governments in Higher Education, 1946-68
(t-statistic in parentheses below coefficient; significant coefficients are underlined)

Investment (Dependent variable)	Pre-tax personal income Y_t	College age Pop. C^a	Inequality (Gini coefficient) g_{kt}	Actual growth rate of GNP g^b	Own (shadow) price P_{S+L}	Stock of HE capital S^c_{ET-1}	Constant term	ρ	R^2_ε (after ρ) SE_ε
(7) Public universities (R^2_u=.952, SE_u=115) DW = 1.93	.0029 (3.79)	13,706. (5.52)	1,346 (1.37)	-20.2 (-2.79)	.619 (3.10)	.036 (1.57)	-3,627. (-5.65)	.53	.997 30.4
(8) Public 4 yr. colleges (R^2_u=.919, SE_u=75.5) DW = 1.80	.0018 (2.69)	13,396. (7.00)	1,632 (1.77)	-10.1 (-1.86)	1.19 (5.63)	-.015 (-.92)	-2,492. (-5.36)	.30	.989 27.4
(9) Public 2 yr. colleges (R^2_u=.911, SE_u =50.9) DW = 1.22	.0026 (2.92)	7,849. (2.08)	160. (.12)	-.536 (-.07)	.741 (2.08)	-.054 (-2.19)	-880. (-1.43)	.43	.947 39.2
(10) Public total (R^2_u=.927, SE_u=259) DW = 2.02	.0060 (3.23)	34,947. (6.84)	4,407. (1.85)	-44.2 (-2.59)	2.35 (3.79)	.033 (.62)	-9,241. (-6.36)	.46	.993 75.6
(11) Private universities (R^2_u=.960, SE_u=3.31) DW = 2.25	.0001 (3.47)	278. (5.57)	150. (3.58)	.191 (.65)	.620 (16.78)	-.0016 (-2.06)	-115. (-5.28)	.22	.994 1.32
(12) Private 4 yr. colleges (R^2_u=.984, SE_u=.820) DW = 1.44	.00003 (3.06)	128. (3.73)	13.2 (.92)	.018 (.19)	.947 (8.82)	-.0006 (-2.13)	-20.9 (-2.76)	.48	.996 .427
(13) Private 2 yr. colleges (R^2_u=.889, SE_u=117) DW = 2.02	.000009 (3.68)	7.55 (.81)	4.80 (1.59)	.023 (1.77)	.047 (7.44)	-.0002 (-3.35)	-2.60 (-1.57)	.11	.934 .091
(14) Private total (R^2_u=.971, SE_u=3.87) DW = 1.96	.0001 (2.82)	430. (5.22)	160. (2.13)	.152 (.28)	1.46 (7.78)	-.0008 (-.58)	-168. (-4.35)	.99	.989 2.40

[a] Percent of population age 16-26 for universities, 16-22 for 4 yr. colleges, and 16-20 for 2 yr. colleges respectively

[b] Five-year moving average rate of growth of real GNP.

[c] Number of persons age 25 and over with one or more years of college completed.

cases except for junior colleges. There the strongest effect of the numbers of young adults on expenditure levels may have come with a lag in more recent years.

Expected real future income added by higher education (Y^e_{Bt}) did not prove significant when introduced. The measurement of expectations, however, had to be based in the usual way on current and past income differentials. But alternatively, a low actual growth rate (g) could be expected to stimulate state investment efforts, and the more significant negative coefficients for investment at public universities and 4-year colleges in column g of Table 1 are consistent with this hypothesis.

The inequality coefficient (g_k) is positively associated with state investment at public colleges and universities and at private universities. This is consistent with the hypothesis that the public sector seeks a correction through public expenditure to the existing income distribution, but the effect as measured here is not a strong one.

The effective price per student in real terms paid by the state and local government (p_{S+L}) to support larger enrollments is significantly and positively associated with larger state and local investment expenditure. This may be partly due to higher unit costs, which in turn are partially the result of higher derived demands for factor inputs at educational institutions, and hence are not completely independent of the demand factors discussed here. The positive coefficients do suggest that state and local enrollment demand is price inelastic.

The stock of human capital in the society formed through higher education (S^c_{Et-1}), when it is significant, has a negative coefficient consistent with the hypothesis that existing stocks are a short term deterrent to

Table 3. Conditional Predictions of Investment by State and Local Governments in Higher Education to 1980
(In millions of dollars, using regression equations from Table 2)

	Constant (1958) Dollars				Current Dollars			
Academic year (beginning)	Public institutions using (17) 1946-68	Private institutions using (18) 1946-68	Public institutions using (15) 1929-68	Private institutions using (16) 1929-68	Price index (P.C.E. deflator)	Predicted all institutions (15 + 16) in cur. $	Actual all institutions	Percent error (predicted from actual)
1969	5,096	119	5,103	118	1.235	6,448	6,722	-4.08%
1970	5,355	126	5,327	125	1.290	7,033	a	a
1971	5,687	132	5,645	130	1.360	7,854	b	
1972	6,209	142	6,127	140	1.340	8,711		
1973	6,782	151	6,691	149	1.440	9,850		
1974	7,200	158	7,154	156	1.480	10,819		
1975	7,707	167	7,704	164	1.510	11,881		
1976	8,193	175	8,228	172	1.540	12,936		
1977	8,715	183	8,789	181	1.581	14,182		
1978	9,200	191	9,320	189	1.619	15,395		
1979	9,686	199	9,869	197	1.661	16,720		

[a] The lag is substantial in the assembling and preparation of educational statistics. The data shown for the 1969-70 academic year were obtained prior to their publication in January 1973, and the data for 1970 and later years are not likely to be available before January 1974.

[b] The spring 1969 student demonstrations may have had a temporary effect on 1969-70 to 1971-72 appropriations. See, however, the close correspondence to predicted values in 1969 above and to 1970 and 1971 appropriations as discussed below in the next section.

The predictions are conditional on the policies implied by the values assigned to the policy variables p_{S+L}, p_{T+F}, and p_F, the policy-determined components of p, the full cost price. Enrollment (q) as well as these price terms are all endogenous in the more general model that results when an explanation has been offered for all of the components of total effective demand. For now, p_{S+L} (as well as p_{T+F} and p_F) have been based on the actual data through 1968, and then on projections of "Student Charges by Institutions of Higher Education" made by George Lind in Projections of Educational Statistics to 1980-81 (1971), 101-108.

State and local investment in post-secondary education includes state and local government appropriations included in the current fund revenues of institutions, state and local support of sponsored research, state and local support of other sponsored programs, and state and local student aid grants[4] as these items are defined in the Financial Statistics of Institutions of Higher Education, 1968-69, p. 16. Recent shifts toward more state grants for direct student aid tend to channel more state aid to private institutions. This is because state grants have normally been limited to tuition and fees which provide a larger sum per student-recipient to the higher tuition private institutions. (Average full cost at private institutions was also $1,256 higher per student than at publically controlled institutions.[5]) This practice fails to meet the needs of low income students whose parents are unable to cover room and board costs for an extended period, but it is urged by those who are less concerned about this than about getting aid to private institutions by means that avoid institutional grants. A voucher system that involves a flat grant to the student that he can use to help with his room and board does not discriminate so seriously against the poor. The mix of these two plans that emerges over the next few years can affect the allocation of state aid as between public and private institutions, but is less likely to be in addition to other state support. If anything, it is likely to diminish the rate of growth of state support, since a shift of funds to institutions not under state control and also toward aid for low income families changes the political basis of support for appropriations bills in state legislatures. The rapid growth of public junior colleges draws on the more long standing and predictable bases of state and local support, while simultaneously lowering out-of-pocket room and board costs. This improves the access of poor families in urban areas to post-secondary educational opportunities. But the basic problem of room and board costs (foregone earnings) remains a serious one for poor families that is only now beginning to be addressed as further thought is given to the structure of federal student aid grants.

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[4] Student aid that is not awarded by institutions (such as that awarded by state scholarship commissions) would not appear here as a receipt of institutions, but would instead be included in tuition and fee receipts.

[5] Ibid., p. 7. Cost per student per year at private universities, taken alone, was $5,124 compared to $3,450 at public universities.

The predictions in Table 3 also are conditional upon the forecasts of the economic and demographic variables on which state and local investment in post-secondary education depends. The two key economic variables, which are real personal income and the price index needed to convert predictions of real investment to current prices are as reported by the Department of Commerce through 1972. The 1973-1979 values are those predicted by the Eckstein-Fromm D.R.I. econometric model of the United States. The stock of educational capital (S_{Et-1}) changes more slowly over time than do flow-type variables, making it useful in forecasting. It was projected to 1980 based on projections of the underlying elements that it contains as described in Appendix B, although in principle a more general model explaining all components of S_{Et-1} as well as depreciation could generate it endogenously. The Gini coefficient (g_k) also changes slowly over time, although it does indicate a decline in inequality in the personal income distribution from 1929 to 1946. This measure of inequality has been pretty stable in the post-war years, dipping slightly toward .33 in the 1963-1969 period but then climbing toward its post-war average of about .35 which is the value extrapolated to 1980. These educational stock and income inequality variables however are less significant than the other determinants of new investment.

Finally, the demographic variable measuring the number of college-age young adults as a percent of the total population (C_t) is calculated from population estimates and projections made by the Bureau of the Census in its Current Population Reports Series P-20. The future college-age population depends on the numbers of children already born and in grades 4-12, so it can be predicted to 1980 quite accurately. The recent growth in college eligibles has leveled off and stops at 19.6 percent of the population in 1973 when the last of the young adults born during the large increase in births following World War II passes beyond the normal Masters Degree level. The percentage of the population in the narrower 18-20 age range begins to decline in the 1974-75 academic year toward its 1970-71 level.

Comparison With Other Projections. The conditional predictions of current expenditures on higher education financed by state and local governments are not available in other sources. Some comparisons can be made to the 1969-1971 estimates made by Forrest Harrison and George Lind in the U.S. Office of Education (1971), Projections of Educational Statistics to 1980-81, which only were done including capital outlays. The current expenditure, current dollar, estimates in Table 3 are 92.1 percent, 89.0 percent, and 90.2 percent of the O.E. current and capital outlay totals in 1969, 1970, and 1971 respectively. (Current expenditures were 90.8 percent of the total in 1968.) The Office of Education has not attempted any projections beyond the 1971-72 academic year of expenditures by higher educational institutions by revenue source.

M. M. Chambers (1972) collects data annually on Appropriations of State Tax Funds for Operating Expenses of Higher Education. His census of appropriations is not identical to expenditures by institutions, excludes appropriations by localities, while including amounts for state scholarship commissions. Fortunately it excludes capital outlays. Dr. Chambers' data for recent years in millions of current dollars, with our Table 3 estimates shown as a percent of his figures, are as follows:[6]

Year	Appropriations	Estimates using basic influences
1969-1970	6,198	104.0%
1970-1971	7,004	100.4%
1971-1972	7,704	101.9%
1972-1973	8,529	102.1%

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[6] M. M. Chambers (1972), p. 3 and earlier issues.

The estimates based on underlying influences on state investment decisions are very close to actual appropriations. This suggests among other things that the effect of campus unrest, most of which would have been felt in the 1969 and 1970 budgets, was less substantial in relation to the more basic political-economic sources of support for higher education than might have been thought at the time.

In the future real personal income movements and future price level trends on which appropriations do depend will be affected by the effectiveness with which federal fiscal, monetary, and income policies are used to maintain full employment and non-inflationary real growth.[7] The conditional forecasts depend on these policies, and not just on specific federal higher education policies, in very important ways.

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[7] Shorter run forecasts are likely to be more accurate than longer run forecasts, in part because fully effective stabilization policies are not always followed.

Chapter 5

Federal Investment in Higher Education

The Education Amendments of 1972 are likely to be as important, if not more important, in their eventual impact on higher education in the United States as the Land Grant Act of 1862. The new act provides for a program of basic grants and related support that for the first time undertakes to extend post-secondary educational opportunities to students from low income homes.

The design of this "basic grant approach," which is essentially a sharply redesigned new public good, has been put forward mainly in Quality and Equality (the Carnegie Commission Report (1968)), Toward a Long Range Plan for the Financial Support of Higher Education," (the Rivlin Report (1969)), and in the Conference Report on the act itself (House of Representatives Report No. 92-1085). Its design has been discussed by R. Hartman (1972) and others. Its implementation is considered by the National Commission on the Financing of Postsecondary Education set up by the act, and by the Office of Management and the Budget. But apart from these design and operational decision aspects, there has been no theoretical or empirical analysis of the political-economic factors influencing the level of federal support.

The future impact of this act now depends primarily on the level of funding. It is an analysis of the longer run influences on which this depends that is the objective of this chapter.

After a brief discussion of the trends in federal support (Part I) as well as of some economic aspects of the newly enacted program (Part II), a model will be set out for analysis of the postwar federal support of higher education (Part III) and regression results will be discussed (Part IV). Some tentative conclusions will be drawn about the prospects for full funding of the provisions of the act in both the short and longer run in Part V. It will summarize some of the constraints, as well as seeking to describe some of the opportunities that define the path of actual progress toward social goods.

I. TRENDS IN FEDERAL SUPPORT

Federal investment in educational capital through educational institutions grew more slowly than investment either by state and local governments or by households in the postwar years, as may be seen in Figure 1. The federal investment made through direct payments to households under the GI Bill are shaded in as subsidized household investments.

In contrast, expenditures by the Federal Government for contract research and the investment that this implies in the creation of new knowledge grew more rapidly and with less interruption throughout the 1941-1968 period than any of the components of investment in education. There are some joint costs (e.g. the support of graduate student research assistants) whose allocation here to the cost of research outputs may understate somewhat the value of the skills and experience acquired by the students. There also has been a curtailment of federal support of research in the 1968-72 period that has lowered the rate of growth of federal support.

Note that the rate of growth of real investment by households in the 1946-49 postwar period was small, relative to the growth of federal support. It presumably can be explained largely in terms of the effect of the lower effective tuition, room, and board price ($p_{T+F} + p_{R+B}$ net of p_F) and of depleted higher educational capital stocks (S_{Et-1}) on enrollments. In general, there has been growth in federal support of higher education in the postwar period, but it has been more sporadic, and from a smaller base that now constitutes about 5 percent of the total expenditures of colleges and universities.

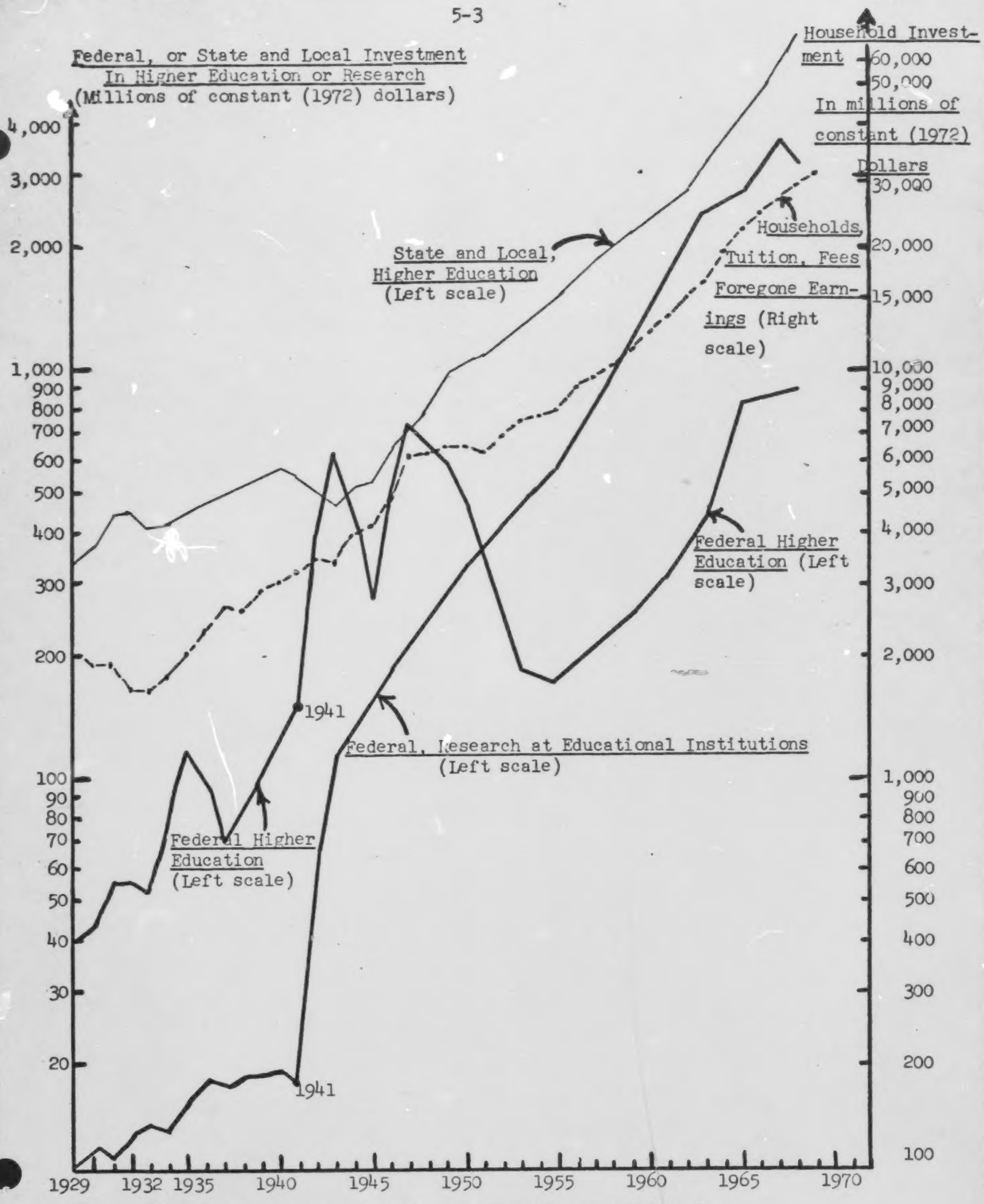

Figure 1. Federal Investment in Higher Education and Research Percentage Rates of Growth Compared. Data Sources: See Appendix C.

II. FEDERAL HIGHER EDUCATION PROGRAMS

The Education Amendments of 1972 build upon and significantly extend a foundation of existing programs. The GI Bill following World War II was probably the most significant piece of legislation affecting higher education up to that time. The 1972 extension of this Bill has raised all GI benefits by 25 percent, retroactive to September 1972. The National Defense Education Act of 1958 established a program of fellowships and direct loans to students that also is maintained and extended by the Education Amendments of 1972 as noted below. There was the Higher Education Facilities Act of 1963, followed by the Higher Education Act of 1965 as amended in 1967 and 1968. The latter began other programs of federal investment in human resources included below.

The most important new feature of the Education Amendments of 1972 is the basic grant program that provides a foundation grant for each student of from $200 to $1,400 depending upon his financial need as defined by his family's economic circumstances. It is intended as a foundation grant on which other programs build. But grant payments will not be made until Congress has appropriated at least $653.5 million to support the existing "supplemental" economic opportunity grant, work study, and institutional student loan programs. Beyond this, the act also provides for new cost-of-instruction aid to institutions based on the number of basic grant recipients that they serve. But this provision does not come into effect until Congress has appropriated sufficient funds to cover at least 50 percent of the basic grant to which each student is entitled.

So the new basic grant and institutional aid provisions are gradually "phased in" only after the main existing programs are funded in the program agreed to by the Congress. Preliminary to considering influences on the level of funding, it helps to consider the five main categories of federal investment in educational capital and their relative scope as indicated by the tentative figures agreed to for fiscal 1975 (in millions) by the House-Senate conferees. They are:

	Millions, 1975
1.) Aid to students based on need:	
a) Basic Educational Opportunity Grants	As appropriated
b) "Supplemental" grants (the current program)	$ 200
c) State student aid (50% of new state effort)	50
d) Institutional programs for the disadvantaged	100
e) Interest subsidy on insured student loans ($2.0 billion limit on principal, underwritten by SLMA)	No limit
f) Work study	420
g) Direct loans to students (NDEA)	400
2.) Categorical aid based on career objectives:	
a) Teacher training programs (OE)	450
b) Graduate school programs, fellowships (OE, NSF)	142$^+$
c) Manpower training programs (Dept. of Labor)	300
3.) In-service training programs:	
a) Department of Defense (post-secondary schools, high per student cost service academies)	343
b) AEC, CIA, NASA, Treasury and Justice Departments operate small in-service programs	

4.) Aid linked to specific public-good demands: This aid is given to those eligible through student voucher programs directly to the student for him to spend where he will.

- a) G.I. Bill aid to veterans (Fiscal 1973, V.A.) 1,706
- b) Social security dependents (Fiscal 1973, S.S.A.) 505

5.) Aid to institutions; cost of education allowances:

- a) 38 percent of all EOG, work study, and NDSL funds awarded by the institution (rising to 50 percent for smaller institutions),
- b) $500 for each basic grant recipient (falling to $100 for each recipient over 1,000), triggered after existing programs and half of the basic grants are funded,
- c) $200 for each graduate student, (a+b+c) = $1,000
- d) $300 for each veteran enrolled No limit
- e) Aid to institutions in distress, using cost analysis 40

Future appropriations for these programs will be jointly determined by the Office of Management and the Budget and appropriations made by the Congress. The OMB in Fiscal 1974 for example has sought to partially fund the basic grants while cutting back existing programs and categorical aid (i.e. 1b, 1f, 1g, and 2a-c).[1] Congress through the Education Amendments of 1972 has protected the existing programs as indicated above, but the hand of the OMB is strengthened by the support of some members of Congress and the threat of veto of appropriations bills that do not conform to OMB proposals by President Nixon.

Crucial features, therefore, are those provisions for "ratable reduction" and partial funding of the basic grants that are set out in the act, since partial funding is inevitable for some time to come. Most important, at anything less than half funding of the basic grants, the basic grant cannot exceed 50 percent of the student's actual need. If appropriations are insufficient to satisfy even this level, not only the institutional aid is cut out but also all $200-1,400 basic entitlements are ratably reduced.

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[1] U.S. Executive Office of the President (1973), The Budget of the United States Government, Fiscal 1974. Category 1 was budgeted at $913 million in 1972-73.

The student's actual need is defined as the student's "actual cost" of attending including tuition and fees, room and board, books, and commuting expenses, net of an expected contribution from his family. The latter is determined by his family's and his own income and assets, including in the latter all benefits received if he is a social security dependent and one half of any veterans benefits. Even at full funding, basic grants are limited to half the cost of attending the institution. Students can supplement the "half-need" limitation of the basic grants with supplemental EOG's state scholarships, work study, larger family contributions, and loans.

Insufficient appropriations therefore will restrict the basic grants made to the students from the poorest families by the largest absolute amounts. Since these grants can meet only half their need, and even at full funding, only half the cost of the institution (or $1,400 less the expected family contribution, whichever is less), about half of the amount appropriated will go to students from the second or $6-11,000 income quartile and is poorly targeted on those students with the greatest need.[2] The mix in the final package of aid using state scholarships (state student incentive grants provisions), supplemental EOG's, work study, and loans will affect this targeting of the aid. But the current tendency for the low income family's contributions to be a larger percent of its income, the hours of work for students from such families to be longer (a strain on a full time student if over 10-15 hours a week), and their education debts to be larger is apt to continue. So although funding the act will go a long way, there are economic constraints and some regressive inequalities in educational opportunity will remain. The latter is reduceable, however, by the funding and the direction given to the supplemental EOG's.

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[2] For specific estimates of how the half cost provision "targets" aid less effectively on low income students see Robert Hartman (1972), pp. 465, 474, and his Appendix B.

In another important effect, the half-cost provision channels a disproportionately large amount of aid to high tuition private institutions. Similarly the state student incentive grants also lean heavily in the direction of aid to private institutions because state programs normally limit grants to tuition and fees and exclude room and board costs.

Some aid to middle income groups and to private institutions is in order, and the level of funding of these different provisions of Public Law 92-318 is one means of controlling the "mix." But one is left with the fact that private institutions do have much higher full costs per student, even though quality, the proportion of graduate students, and accounting practices do differ.[4]

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[3] Other provisions in the act for aid to junior colleges and institutional aid on a flat per-student basis counterbalance this to some extent.

[4] True unit cost comparisons in the sense of cost per unit of output of "education" of constant quality are very difficult and some years into the future.

Caution will have to be used to avoid making the inducements to choose the high cost private institutions too strong. That would increase the aggregate tax cost of the act, and interfere with the maximum extension of educational opportunities. Caution will also have to be exercised to keep the aid from merely re-enforcing current tendencies toward ineffective "token" grants from institutions for students with little need. The "targeting" of the aid on the students from low income families who currently are excluded because of their large unmet need is the act's single most important feature.

III. PUBLIC EXPENDITURE THEORY: A POSITIVE MODEL FOR USE IN ANALYSIS

The federal political mechanism just described may be regarded as the vehicle through which economic constraints on the attainment of social goals are transmitted. The primary goals for social investment in higher education relate to returns extending over future periods; they will be expressed first, and simply, as growth of real satisfactions, and equity. But the economic constraints on their attainment also must be made explicit if there is to be any derivation of effective demands. The economic constraints are very real, although they may sometimes be disguised by a veil of political manuveuring.

Social Goals

A multiperiod objective function expressing current and expected real satisfactions enjoyed by citizens is given in the simplest possible form below. It is analogous to the democratic state preference function, or modified welfare function, for a state government discussed in Chapter 4. It measures private satisfactions enjoyed in terms of real incomes, assuming some imputations for non-monetary returns.

$$(1) \quad W_T = W\left[\sum_{k=1}^{m} g_{kt} Y_{kt}\right] \qquad t = T,..,L.$$

where Y_t = current and expected future real personal income including imputations,

g_{kt} = income distribution weights attached by elected officials reflecting the importance they attach to increasing the satisfactions of the kth income class,

W = a modified welfare function, or democratic state preference function, that includes the influence of social benefits (externalities).

All five categories of federal investment in higher education are designed to contribute to the social goal of growth of current and expected future satisfactions (i.e., to Y_t as t = T, T+1,..,L.) Private income returns are also returns for the society. Private returns include imputed returns to private citizens from public goods, but the overlap between private and social returns is not necessarily 100 percent since there are also purely social benefits in the form of externalities implicit in W.[5] These take the form of the discovery and development of talent that contributes to innovation and culture beyond payments received, reduced crime rates and related social problems, and the strengthening of political and civic leadership from which others benefit.[6] Notice that Y_k involves returns in the form of satisfactions for all citizens, not just those in the lower income brackets.[7] And in fact some higher education programs such as NDEA loans serve primarily middle income groups. Finally, notice that this goal as it stands is a virtually limitless utopian ideal before any constraints from program costs and taxes have been introduced.[8]

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[5] Some economists are denying the existence of all externalities (excluding pollution) with capitalization and measurement arguments that in the author's opinion constitute an almost unbelievable defiance of common sense.

The second goal (vertical) equity, is expressed in the personal income distribution weights g_{kt}. As suggested in Chapter 4, they will tend to be larger in democratic countries for each dollar of income arising in the lower income families than for each dollar of income at the other end of the scale since votes are distributed more equally than are private sector incomes. The first category of higher education programs providing aid based on financial need serves this goal of vertical equity most directly. Other programs also serve it, but less directly.[9]

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[6] Cartter (1972) has estimated private benefits at 75 percent and social benefits at 25 percent of the total with a degree of precision and comprehensiveness that surely overreaches the state of the art, while commendably encouraging work on measurement. For good discussions of social benefits of higher education see Hartman (1972), Mundel (1972), and Bowen (1972).

[7] Reasons relating to the election of those who govern are discussed further in Chapter 4.

[8] Efficiency in the attainment of growth is therefore another matter. Resources must be invested in relation to costs where rates of return are highest, although care must be used to include non-monetary and social returns.

[9] The "director's effect" suggests that individual programs tend to benefit the most those persons that are toward the middle of the income range that the program is designed to serve. This certainly is true of public higher education institutions at present taken as a whole But this fact is not inconsistent with this analysis, for if the distribution of benefits is more equal than the distribution of income in the private sector, the program would still be redistributive, in relative terms.

A third goal, that of satisfying demands for particular public goods (which are included in Y_t) such as defense and social security is served most directly by categories 3 and 4 of the education programs. Defense and social security are largely social goods, as is the social benefit element in education. This means that the exclusion principle which is essential to enforcement of the prices that are necessary if private production is to occur cannot be effectively applied, and/or there are substantial cost economies making public production more feasible. There is an overlap in these demands, for example, for defense (and veterans benefits) with the demands for education, so that some higher education programs gather support from both sources.

The Economic Constraints

The degree to which social goals can be attained is limited by the constraints imposed by the total resources available in the society and by the cost of specific programs.

First, there is the constraint of the limited total resources available to the society at any given time for allocation between private goods and public goods, the latter including federal support of higher education. This economic constraint assumes that the federal budget operates with a fixed net deficit, or is nearly balanced, over the recession-prosperity cycle taken as a whole. Total personal income for the planning period therefore represents the total resources available for allocation.[10] Maximizing total public and private satisfactions[11] subject to this constraint, an

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[10] See Chapter 4, equation (2).

[11] See Chapter 4, equation (4). It replaces the Y's in (1) above with q's, and treats the g_k's as taste parameters for ease in derivation. This procedure releases the assumption of one fixed set of relative prices implicit in (1).

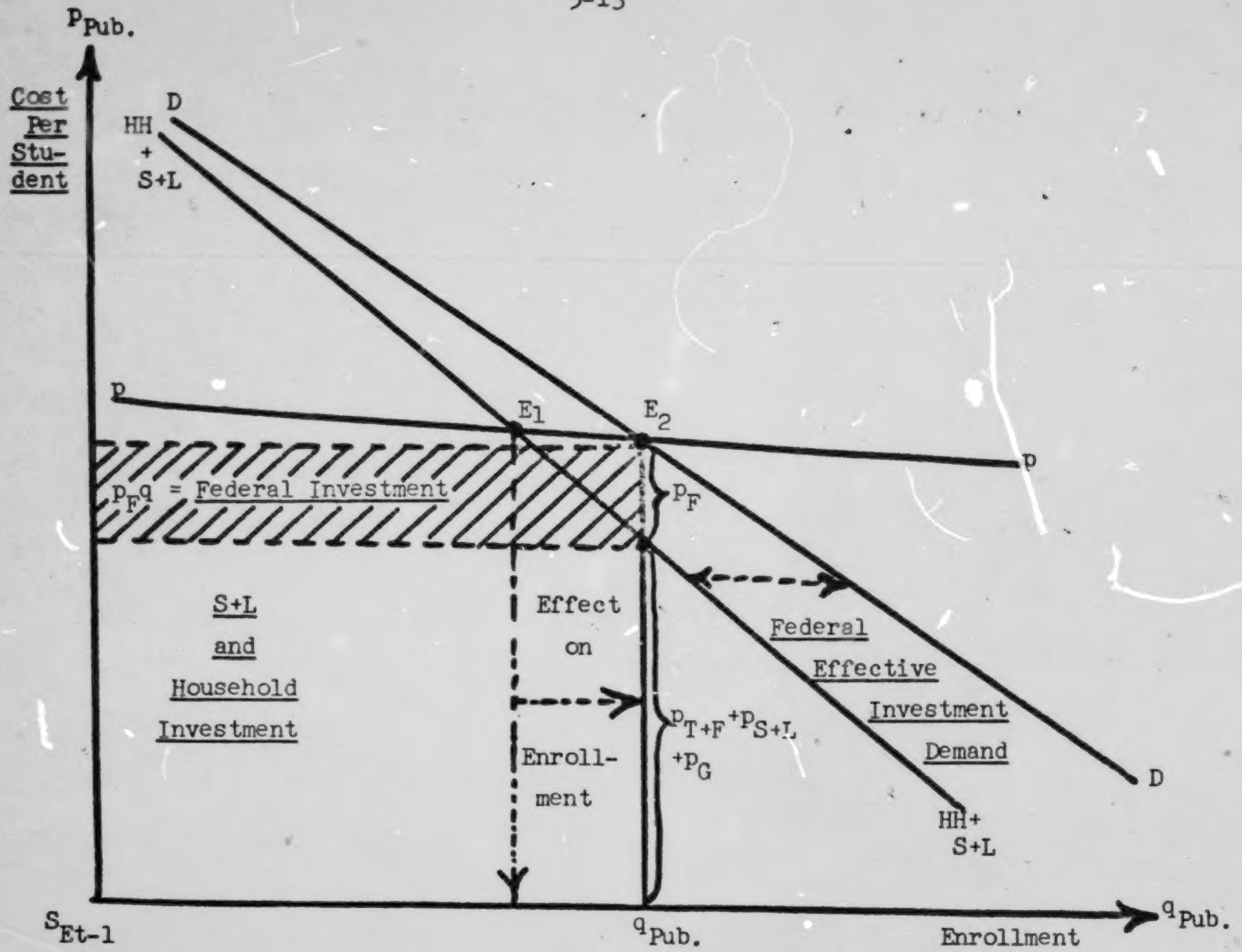
$p_{Pub.}$
Cost Per Student
D
HH + S+L
p
E1
E2
p
p_Fq = Federal Investment
p_F
S+L and Household Investment
Effect on Enrollment
$p_{T+F}+p_{S+L}+p_G$
Federal Effective Investment Demand
D
HH+ S+L
S_{Et-1}
$q_{Pub.}$
Enrollment
$q_{Pub.}$

Figure 2. Federal Investment in Higher Education at Public Institutions. (Enrollment demands are derived demands for inputs used in the production of human capital.)

effective demand for enrollment to be added by federal investment can be derived. When expressed as a function of the average price per student to the federal government (p_F), this incremental investment-demand may be added vertically to the demands for higher education arising from other sectors to obtain total enrollment demand illustrated as DD in Figure 2.

Second, there is the constraint imposed by the cost of the program. It is useful here to start with the full cost of sustaining the student at the institution, illustrated by line pp in Figure 2.[12] Equilibrium without the federal investment would be at E_1; by increasing the federal subsidy (p_F) total enrollment can be increased, say to E_2 in the case of public institutions that is illustrated. The limits to this process are that federal investment represented by the shaded area p_Fq incurs a tax cost in dollar terms that must be met. Using either discretionary or automatic adjustments in effective tax rates,[13] taxes simultaneously incur disutility (or dissatisfaction) by reducing Y_t and hence reducing the utilities described by the modified welfare function given above.

A Partial Enrollment Model

These effective demand and cost effects can be illustrated by the part of an aggregate enrollment model shown in equation (2) below. Enrollment demand (q_{Pub}) turns out to be a positive function of current income (Y_t) and expected future returns (Y_{Bt}), which both come from the total resource constraint. It is also a positive function of the four year moving average of the number of veterans in civil life (V_t). The latter together with the measure of existing inequality in the income distribution (g_k) derive directly from taste parameters in the democratic state preference function. Larger federal subsidies to institutions (p_F) which retard the rate of increase of tuitions and fees also are significantly associated with increased total enrollments in the postwar period.

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[12] This supply function based on production costs assumes to simplify the problem that nonprofit institutions merely supply enrollments at average cost. Some students of course are charged more and others less through financial aids. An institution can choose to charge a higher average price, offering education of higher average quality, which shifts the cost function pp upward.

[13] For the tax function with rates like t_1 and t_2 to be adjusted see Chapter 4, equation (3).

$$(2)\ q_{Pub} = \underset{(2.50)}{\underline{.0049}}\ Y_t\ \underset{(3.17)}{\underline{+.379}}\ Y^e_{Bt}\ \underset{(-1.78)}{-4390}\ g_k\ \underset{(3.37)}{\underline{+.0206}}\ V_t\ \underset{(4.36)}{\underline{+5.82}}\ p_F\ \underset{(2.76)}{\underline{+.0094}}\ S_{Et-1}\ -1418$$

Where federal investment, rather than enrollments is the dependent variable, the significance and direction of most of these effects are very similar, as will be seen next in Table 1. The only really notable difference is that the existing stock of educational capital (S_{Et-1}) appears to act as more of a deterrent to new federal investment than it does to total enrollment.

IV. FEDERAL INVESTMENT REGRESSION RESULTS

Federal investment-demand functions are presented below in Table 1. They emphasize those influences that shift the demand curve in Figure 1 outward, thereby increasing real federal investment expenditure (the shaded area), which is the dependent variable. Changes in costs, of course, will also influence expenditure, especially increases in faculty and non-faculty salaries which shift the average total cost function upward. But many of these nominal cost increases are not increases in the relative costs of education but instead reflect general conditions in the economy, so these are removed by deflation of investment expenditures for changes in the price level.[14] Other cost increases are induced by increased demands for education coming from households and from state and local governments. So although changes in real costs make it more difficult to get unequivocal hypotheses

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[14] The Personal Consumption Expenditures implicit deflator is used for deflation throughout. It is used for public expenditure here because it is likely to be closer to a shadow price of final public goods to the collectivity than is a deflator based only on factor prices.

Table 1. Investment by the Federal Government in Higher Education, 1946-68
(t-statistic in parentheses below coefficient; significant coefficients are underlined.)

Investment (Dependent variable)	Pre-tax personal income Y_t	Expected monetary returns Y_{Bt}	Inequality (Gini coefficient) g_k	Veterans V	Employment rate N	Party control (Democrats) D	Stock of HE capital S_{Et-1}	Constant term	ρ	R^2_ε after ρ SE_ε
(3) Public universities (R^2_u=.846, SE_u=29.0) DW = 1.81	.0017 (2.42)	.0459 (.68)	-3,412 (-3.70)	.0021 (2.14)	-15.78 (-1.74)	9.58 (.44)	-.0025 (-2.36)	2,513 (2.50)	-.13	.849 28.7
(4) Public 4 Yr.colleges (R^2_u=.886, SE_u=14.5) DW = 1.71	.0006 (2.00)	.0005 (1.66)	143 (.36)	.0035 (4.27)	3.39 (.91)	13.82 (1.54)	-.0003 (-.58)	-482 (-1.15)	.05	.923 11.9
(5) Public 2 Yr.colleges (R^2_u=.20, SE_u= 68.3) DW = 1.36	.0003 (3.59)	.0110 (1.57)	-63 (-.65)	.0003 (1.08)	-1.27 (-1.40)	-1.99 (.97)	-.0001 (-.91)	-33 (-.32)	.95	.948 3.4
(6) Public total (R^2_u=.934, SE_u= 32.3) DW = 2.14	.0025 (4.39)	.0771 (1.31)	-3,533 (-4.42)	.0068 (4.50)	-7.38 (-.89)	27.30 (1.42)	-.0032 (-3.57)	1,534 (1.68)	-.43	.950 28.0
(7) Private universities (R^2_u=.851, SE_u= 18.3) DW = 2.31	.0007 (2.39)	.0720 (2.32)	-2,187 (-5.20)	.0042 (5.31)	-2.70 (-.61)	17.94 (1.76)	-.0017 (-3.65)	897 (1.85)	-.50	.895 15.3
(8) Private 4 Yr.colleges (R^2_u=.824, SE_u= 13.8) DW = 1.98	.0004 (1.60)	.0357 (1.45)	-530 (-1.58)	.0043 (6.62)	4.54 (1.35)	18.49 (2.30)	-.0009 (-2.44)	-317 (-.85)	-.26	.890 10.9
(9) Private 2 Yr.colleges (R^2_u=.559, SE_u= 15.1) DW = 1.76	.0001 (1.89)	-.0004 (-.17)	-12 (-.38)	.0003 (3.82)	.21 (.72)	19.69 (2.74)	-.0001 (-1.86)	-19 (-.56)	.17	.819 1.0
(10) Private total (R^2_u= .860, SE_u= 30.0) DW = 2.37	.0012 (2.42)	.1152 (2.33)	-2,724 (-4.05)	.0088 (6.90)	3.22 (.46)	37.53 (2.32)	-.0027 (-3.69)	431 (.56)	-.45	.912 23.8

about demand alone, relative cost changes are both smaller than the nominal changes and furthermore are in large part demand-induced.

No predictions of federal investment in higher education using regression equations will be attempted because there is a sample of just one expenditure unit involved and the possibility of large transitory disturbances. The determinants instead in Table 1 offer insight into some of the underlying sources of support in the longer run.

Current Resources and Potential Growth

Increases in real income (Y_t) are significant in providing resources to finance increased federal investment in higher education. Results in Column 1 of Table 1 are fully consistent with this hypothesis.[15] The effect is similar to that for investment by households and by state and local governments. It appears to be reversable in that recessions appear to slow down or stop the rate of increase in investment in higher education after a one year lag by all three types of expenditure decision units (e.g. see Figure 1, 1931-33 and in part 1971-72). The marginal propensity for federal investment out of current income at public institutions in Table 1 is about twice what it is at each corresponding type of private institution.

The absolute difference in returns to those with a college education over returns to those with a high school diploma (i.e. Y_{Bt}, not all of which can be attributed to the economic productivity of the additional training), is positively related to federal investment. Although this absolute difference can and apparently does induce additional investment,[16] it has not come through here or elsewhere when other influences are taken into account as one of the most significant influences on the expenditure of real resources. But expected non-monetary private returns and social returns are not taken into account by this measure. Furthermore, although new investment in higher education may be expected to make a positive contribution to the growth of real income (based on the past real income differentials used to measure Y_{Bt}), it may or may not be the most efficient route to attainment of the growth objective. Efficiency depends upon relative rates of return on alternative uses of the portion of the new resources intended for attainment of growth.

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[15] Expenditures on higher education in turn generate income. But this effect which is similar to that in any consumption or investment function can be expected to be weaker (since other things also generate income), and to occur only after a lag.

Equity

Increments in federal aid to students based on need[17] do not appear to be dependent in Table 1 on the degree of inequality in the income distribution (g_k), but instead on the growth of total resources (Y_t) over time, and conceivably on expected potential returns (Y_{Bt}) as these students become productively employed.

Joint Demands

Joint demand for defense and education have been an important source of increases in federal investment in higher education in 1941-42 as well as through the National Defense Education Act in 1958. Similarly, the large number of veterans following each war has been associated with increased federal investment at almost all types of educational institutions, as evidenced by the "Veterans" column in Table 1.

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[16] See also R. Freeman (1971)

[17] This does not refer to a shift within this category to basic EOG's with the total substantially unchanged.

Direct support of room and board through voucher payments that go to individuals for them to use as they please have constituted a long standing and very important form of federal support for higher education. The payments of this type made through each "Gl Bill" by the Veterans administration are shown in Table 2 (similar but much smaller payments are made through the Social Security Administration dependent's program). There are other smaller post-secondary education programs in other departments, but there is not even any centralized collection of data on their scope, much less any effort to coordinate them in a more comprehensive national education policy.

Stabilization

The net relation between the employment rate (N) and real investment in Table 1 is not significant. Although higher education has not acted as an effective counter-cyclical stabilizer, it has stabilized the transition to a peacetime economy in the past, as well as in the present, by absorbing large numbers of veterans and simultaneously helping them to accumulate skills.

Political Party Effects

There is some indication in Table 1 that the periods in which Democrats were in control of both executive and legislative branches were the ones in which federal investment increased most rapidly. The effect only appears to be significant for investment at private four year and private two year colleges. But a similar variable for Republican party control was tried in regressions not reported here, and one must conclude that federal investment through higher educational institutions has not been

Table 2. Federal Investment in Higher Education Made Through Veterans Benefits
(in millions of current dollars)

Year[a]	Total amount paid to		World War II veterans[b]		Korean (52-64) and Post-Korean (66-72) Bills		Reporting allowance institutions
	Individuals	Institutions	Individuals	Institutions	Veterans	Dependents	
1946	459.0	331.1	459.0	331.1			
1947	481.0	509.3	481.0	509.3			
1948	553.4	486.4	553.4	486.4			
1949	541.4	446.9	541.4	446.9			
1950	403.5	338.3	403.5	338.3			
1951	266.3	248.2	266.3	248.2			
1952	168.8	119.5	112.1	118.3	56.7		1.2
1953	203.9	57.7	45.4	55.0	158.4		2.7
1954	314.0	29.2	17.5	24.4	296.5		4.8
1955	416.0	18.0	5.6	11.4	410.4		6.6
1956	457.0	9.9	.6	2.8	454.2	2.2	7.1
1957	426.0	6.8	.09	.1	421.2	4.7	6.7
1958	354.3	5.8	.02	.2	347.8	6.5	5.6
1959	242.0	4.0	.006	.1	233.1	8.9	3.9
1960	157.9	2.6	-.006	.1	145.5	12.4	2.5
1961	99.8	1.5	-.006	.02	82.9	16.9	1.5
1962	65.9	.9	.002	.02	44.8	21.1	.9
1963	46.9	.6	.001	-.005	25.1	21.8	.6
1964	32.1	.3	.002	.002	8.9	23.2	.3
1965	28.0	.2				28.0	.2
1966	246.9	.001			215.9	31.0	.001
1967	370.2	1.4			334.9	35.3	1.4
1968	468.4	1.8			431.1	36.7	1.8
1969	710.1	2.3			665.1	45.0	2.3
1970	1,179.7	3.0			1,117.3	62.4	3.0
1971	1,381.3	3.6			1,312.5	68.8	3.6
Total[c]	10,171.4	2,648.3	2,983.6	2,591.4	6,762.9	424.9	56.9

Source: Data generously provided by Roland C. Hartman, and Edward R. Silberman, Director, Management and Budget Service, Veterans Administration.

a. Given for academic years, listed by first half of the academic year (i.e., data shown for 1946 applies to 1946-47 fiscal year).

b. Payments of 29.6 percent to individuals and 58.3 percent of payments to institutions made under this act were used for higher education. Annual figures which were not available on this basis were obtained by applying these percentages to each column involving World War II veterans.

c. All totals are for 1944 through 1971.

a strongly partisan matter. The final version of the Education Amendments of 1972 passed in the House of Representatives for example with a slight majority from both parties.

Higher Education Capital Stocks

Existing stocks of educational capital do appear to act as a deterrent to new federal investment. (See the negative coefficient of S_{Et-1} in Table 1.) The Rho coefficient (ρ) however is also negative in those instances where the coefficient of S_{Et-1} is negative and significant (i.e. (3), (6), (7), (8), and (10)).

It is important to distinguish excess stocks of college graduates in certain fields (i.e. engineering, physics, aerospace) that arise because of cyclical declines and structural shifts, from long run secular overproduction (or underproduction) of college graduates in general. The June 1971 and June 1972 gluts in engineering came in recession years. While unemployment of blue collar workers is high, firms always tend to slack off in their new hiring of engineers and other college graduates.

The possibilities of longer run overproduction of college graduates is a different matter. But this subject is best considered in the next chapter, together with obsolescence and the creation of new knowledge through research.

V. THE CHALLENGE IN THE NEW FEDERAL ROLE IN HIGHER EDUCATION

By far the most important new challenge addressed by the Education Amendments of 1972 lies in the steps being taken to open post secondary educational opportunities for the first time to significant numbers of students from low income families. If this is to be successful it is necessary that the financial aid be targeted better on those who need it, that the quality of low cost junior colleges be strengthened, and most of all that there be creative and innovative development of new approaches that motivate family production of educational capital using new curricula.

Improved targeting of aid requires elimination of the half-cost, half-need provision, or at the very least, its replacement with some kind of a sliding scale. It also requires operation of a need analysis system at least as effective as those that are operated by the American College Testing Program and by the College Scholarship Service. It should obtain the parents' income and asset information directly from the parent while he refers to his tax records, contain built in checks for accuracy in the reporting of assets, and not be satisfied with student's estimates of these items which are well known to be extremely inaccurate.

As this new group of urban poor are enrolled primarily in the lower cost junior colleges, but also to some extent in the BA degree and graduate level senior institutions, workable curricula must be developed. There is need to relate curriculum and apprenticeship training to national as well as local manpower needs, meeting shortages where rates of return are high in skilled trades and vocations from plumbers to doctors, circumventing barriers to entry that have often become formidable. There is the closely related need to develop curricula that are meaningful to the student. This process can draw in part on the successful experiences in agriculture and engineering that emerged from the Land Grant Act. But its success also depends on recognition of the different characteristics of students that come from poor urban families. Educational capital basically is produced by the family, and the model offered by the parent, as well as parental guidance and support, are very important. For seriously disadvantaged students the new act does seek to replace this in part with institutional services and guidance. But simultaneously there is the serious need for more basic research on the production of educational capital by the family. It is a production and investment process extending over the life cycle that most emphatically includes both pre-school and college levels.

Another new challenge presented by this act lies in the possibilities implicit in it for virtually eliminating some of the worst aspects of unemployment. There is the possibility of varying the rate of funding of the supplemental EOG provisions in response to the unemployment rate in the 18-20 year old age bracket so that the supplemental EOG's act as a built-in-stabilizer. The unemployment rate among 16-19 year olds is currently 15.3 percent and is normally about three times the rate for all civilian workers. This would draw many new entrants out of the labor markets at times when unemployment is high (thereby improving markets for others), and support investment in the accumulation of skills at times when forgone earnings costs are low and hence rates of return on the investment in relation to these costs are high. Stabilization effects would work automatically in the other direction in periods of full employment and inflationary pressures since larger amounts of skilled, productive manpower would be released into labor markets when they are tightest. The stabilization effects of Veterans GI Bill benefits following wars should be integrated with the counter-cyclical stabilization effects of modified EOG's toward attainment of this more broadly defined stabilization goal.

The most obvious challenge presented by the new federal role lies in meeting society's desire that higher education make significantly positive and efficient contributions toward the attainment of real growth defined to include the non-monetary private and social returns discussed above. This primarily implies calculating relative rates of return for use in improving the efficiency of allocation decisions. There is some evidence for example that rates of return are higher for resources invested in pre-school education, in improving the quality of secondary education in poor and rural areas, in training more doctors,[18] in supporting good students from low income homes, and in improving the quality of junior colleges, then are rates of return for support of mainstream BA and graduate degree programs. But there is serious need for research to expand these rates of return to include imputations for non-monetary private returns and imputations for (non-private) social returns through improved measurement of the benefits of education. The price of the failure to do this will be distortion of social decisions due to errors of omission. The efficient attainment of real growth also implies federal support for efforts to raise rates of return. This can be done by improving the efficiency of the entire process of producing educational capital. It can also be done by support for the creation of new knowledge through research which opens new higher return investment opportunities.

In conclusion, the situation that exists is itself a challenge inviting the development of a more comprehensive National Education-Economic Policy.

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[18] The argument that there is only a mal-distribution of doctors seem to overlook the fact that average incomes of urban specialists of about $120,000, of GP's of about $60,000, and long waiting lists are economic symptoms of acute shortages in an area where demands are income-elastic and growing rapidly.

The investment in human resources now scattered among the Veterans Administration, Department of Labor, Social Security Administration, and Office of Education needs to be drawn together in the Budget and elsewhere in a more integrated approach. The production of educational capital by households occurs over its entire life cycle, and it is not surprising that progress with some of the problems in post-secondary education depend on making progress with those same problems at the primary and secondary levels. Finally, an integrated policy dealing with the economic aspects of educational policy needs to diffuse the race issue which has interfered with educational policy in the past by stressing the basic goals of real income growth (as defined broadly here), equity, and cyclical stability which tend to be held in common by all citizens.

Chapter 6

Federal Investment in Research at Institutions of Higher Education

New knowledge is created primarily by the work of individuals engaged in a wide range of different kinds of research. Higher education embodies this new knowledge in individuals, together with pre-existing knowledge and an orientation to creativity that together are important to the maintenance and progress of civilization.

There is an interdependence between the allocation of resources to research and to education. New knowledge created by basic research, about one half of which is done in universities, presents new opportunities for high return investment in educational capital.

This embodiment of the new knowledge is necessary if the knowledge is to be applied and made effective. Also the more up to date background is essential feed-back support for continuing new research.

It is quite surprising that so little has been done in the literature on the allocation of resources to university-based research. But because it is in part a joint product with education, while simultaneously creating new opportunities for investment in education, it is appropriate that this chapter analyze the support for those types of research that are most closely interdependent with educational capital formation.

Basic research must be supported almost entirely by governments and foundations because the returns are almost entirely in the form of social benefits that cannot be collected by private agents through application of the price mechanism's exclusion principle. It differs from the patentable inventions of applied research in this respect.

Because the benefits from basic research are largely social benefits, the returns are very hard to measure accurately. T. W. Schultz and Zvi Griliches, however, have estimated rates of return to society from agricultural research on hybrid corn, sorgum, poultry, fertilizers, and agricultural extension based on the value of inputs saved, at 35-57 percent per dollar invested.[1] Comprehensive estimates of return to research in other disciplines such as educational psychology (e.g. improved efficiency in learning), economics (e.g. elimination of depressions), government (e.g. improved workability of social programs), or medicine (e.g. less illness) are not available but they are likely to be high.

It is clear that most advances in knowledge do not contribute directly to the growth of measured national income. The contribution is indirect, showing up through increased labor force participation rates for example, or through improvements in the quality of final products,[2] or through similarly unmeasured improvements in social welfare. That portion of the advance in knowledge that does show up in measured income growth is that that reduces cost, roughly estimated by E. Denison at one-fourth of the U.S. growth rate for the 1950-1962 period.[3] There is no way of knowing how much either basic or applied research contributes to these advances in knowledge.

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[1] T. W. Schultz (1971), "The Allocation of Resources to Research," p. 243.

[2] Applied end results usually are made possible by developments at a more basic level.

[3] That is, .76 percentage points. See Denison (1967), p. 281.

However, returns to research do exist, as evidenced in the widespread support of research by firms who must meet market tests as well as in public support related to social benefits, even though much evidence pertinent to allocative efficiency is lacking.

Because of the interdependence of research with the process of investing in higher education and because returns to this research in the form of income growth and improved social welfare do exist, we will turn now to the allocation of resources to the support of university-based research. In Part I the allocation of resources to university-based research is described. A model is presented in Part II to explain federal effective demands for university-based research. It is followed in Parts III and IV with estimates of the interdependent system. Part V is a summary of the conclusions.

I. THE EFFECTIVE DEMAND FOR UNIVERSITY BASED RESEARCH

About 3.5 percent of national income in the United States is spent on research. This is higher than in Europe where the percentages are:[4]

Belgium	1.2%
Germany	1.5%
Netherlands	1.7%
France	1.8%
United Kingdom	2.5%.

A large part of the research effort in the United States is devoted to military and space research, although space research has declined sharply. U.S. non-defense research expenditures (omitting military and space research) at current exchange rates are still about 2-1/2 times as large as the average for these European countries. These cross section comparisons suggest that the effective demand for research is quite income elastic.

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[4] From C. Freeman and A. Young, The Research and Development Effort, O.E.C.D.

Within the United States, the largest single source of demand is through the Federal Government which finances almost 3/5 of all research.[5] Of this, less than 10 percent normally goes to colleges and universities.[6]

The Growth of Support for Academic Research

Academic research is also supported by some state funds and by foundation grants. But it is difficult to separate the use of state funds and endowment funds for research from funds used to support graduate education.[7] Federal and foundation supported research are usually underwritten, however, with contract funds identified with specific research objectives that can be separated in the accounts of institutions.

Figure 1 illustrates the spectacular growth of federally supported research at both public and private colleges and universities from 1928 through 1967, with some declines in the period from 1968 through 1972. Prior to World War II, federal research support going to colleges and universities was relatively small, and was limited mainly to the research activities of state agricultural experiment stations. It will be noticed in Figure 1 that federal research support going to public and to private institutions has been approximately equal in amount. It also is apparent that federal investment in research has not exhibited highly volitile responses

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[5] Economic Report of the President (1972), p. 125.

[6] National Science Foundation, Federal Support to Universities and Colleges, 1963-66, p. 7.

[7] James Dyal is currently finishing a dissertation on the costs of graduate education at the University of Illinois that illustrates the problems.

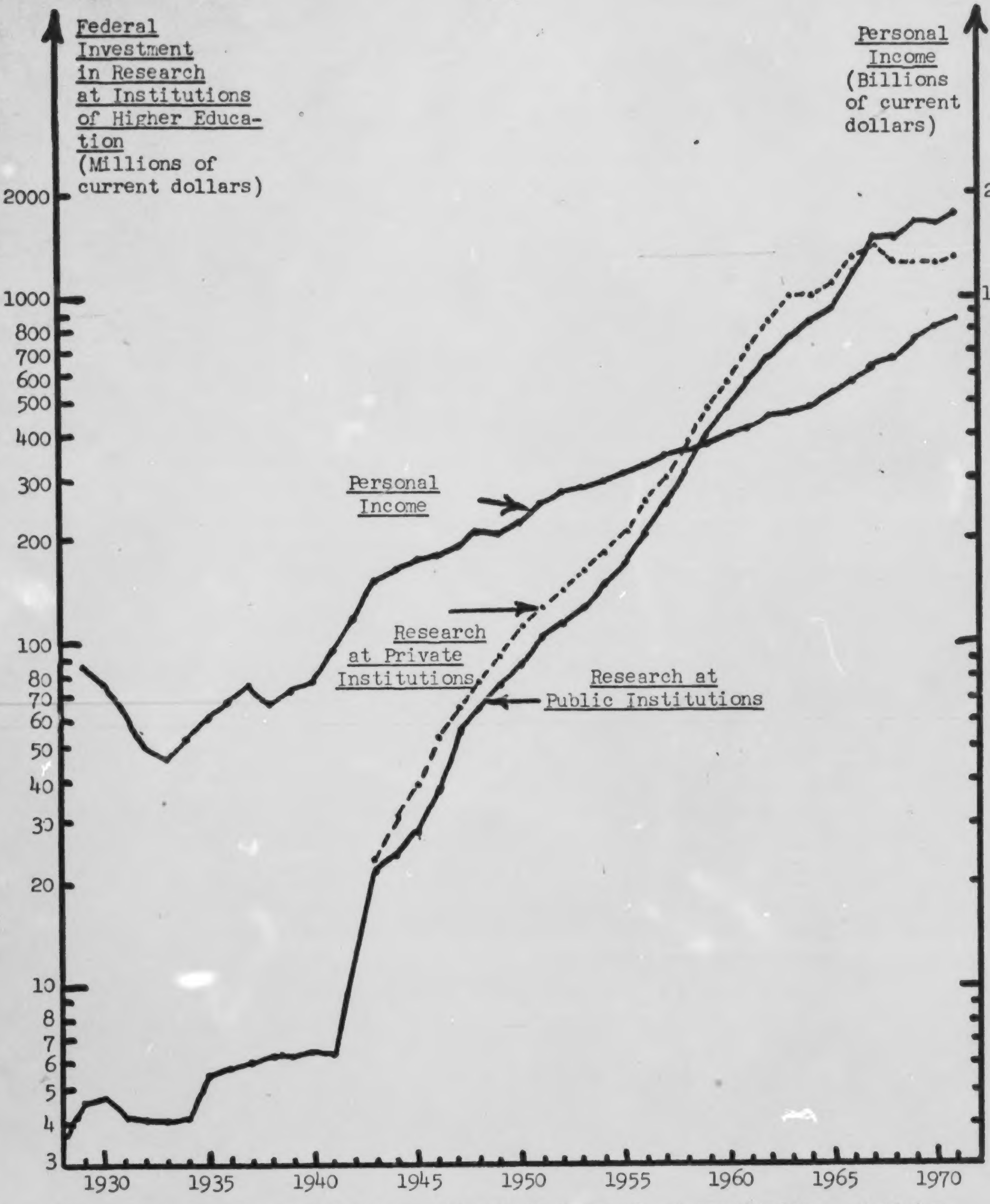

Figure 1. Growth of Federal Investment in Research at Institutions of Higher Education

Sources of Data: Appendix C, and Division of Science Resources Studies, National Science Foundation (for the last three years).

to cyclical fluctuations in either the 1932, 1938, 1949, 1954, 1958, or 1971 recession periods.

The data on federal support of university-based research are developed in Appendix C. The major sources are the U.S.O.E. Biennial Survey of Education (which is the oldest known current series on research expenditures), the bulletins on Land Grant Collges and Universities, and the National Science Foundation National Patterns of R & D Resources, 1953-71.

The growth in federal investment in the creation of new knowledge at universities has been much more rapid than the growth of personal income as also may be seen clearly in Figure 1. This suggests further that research demands over time have a high long run income elasticity.

Externalities and Growth of Basic Research

More than three fourths of all funds spent by colleges and universities for research support basic rather than applied research. As indicated previously the externalities that arise are largely social benefits from which the investor cannot collect a monetary return. So private firms have a limited incentive to support basic research, and prefer applied research that is more closely related to marketable applications. Furthermore, since findings of basic research must first be incorporated in applied research, the findings need to be widely and freely shared, and the eventual returns to basic research are then much longer in coming. Put another way, profit making institutions will underinvest in basic research since there is no way for them to collect all of the returns.

The rates of increase of expenditure for basic research have been highest at colleges and universities, as may be seen in Table 1 below.

But increases have generally been higher for basic than for applied research at all types of institutions.

Table 1. Rates of Increase in Basic and Applied Research by Performing Sector, 1953-1970 (Annual growth rate in percent)

Sector	Basic research	Applied research
Universities and colleges	15.7	7.8
Affiliated research centers	13.9	9.3
Other non-profit institutions	13.8	11.7
Federal government	10.5	8.0
Industry	9.9	9.8
Total	13.1	9.2

Source: National Science Foundation, National Patterns of R + D Resources, 1953-71 (NSF 70-46), p. 3.

These growth rates for basic research when connected to real terms are still over two times as high as the sustainable rate of growth in real gross national product. They suggest that basic research taken alone also has a high secular income elasticity of demand.

Content and Distribution of Federal Investment in Research

Most of the federal support for research at universities and colleges comes from the Department of Health, Education, and Welfare and the Department of Defense. These two departments account for about 40 percent and 25 percent respectively, or 2/3 of the total. The remaining third comes from the National Science Foundation, National Aeronautics and Space Administration, Atomic Energy Commission, Department of Agriculture, Department of the Interior, and Department of Commerce. There has been a shift in emphasis in recent years with space research declining in absolute amount, and health research (which has always been the largest) and education research increasing.

These agencies support research at universities in differing degrees. Over 75 percent of the National Science Foundation research funds go to universities, whereas less than 5 percent of the Department of Defense R + D funds go there. Most defense research is applied research performed by industry, whereas the NSF supports basic research and science education.

Military research is another instance of joint demand in that the demand for defense research at universities is a by product of the effective demand for defense.[8]

Federal support for research is heavily concentrated in a few institutions. There are in the U.S. some 2,000 institutions of higher learning of which 20, or about 1 percent get 60 percent of the federal funds. The data developed in Appendix C, Table C-1, separate expenditures at universities, four year colleges, and two year colleges, revealing that almost all of the federally supported research (i.e. 84-90 percent) was performed at universities. The 8 universities receiving the largest amount of federal research and development funds in 1966 were (in descending order), MIT, Michigan, Stanford, Columbia, UCLA, Illinois, Harvard, and Berkeley.[9]

II. THE MODEL: FEDERAL EFFECTIVE DEMANDS FOR UNIVERSITY-BASED RESEARCH

The Federal Government again is assumed to be an agent acting largely in response to the desires in the electorate for greater monetary and non-monetary satisfactions. It is reasonable to assume that some of these satisfactions can be increased through efforts to advance knowledge through research. It is the major influences on those public agents who determine the allocation of public funds to non-profit research that will be considered here. There is another set of decision makers, those who act as research entrepreneurs in obtaining these funds and using them. This second set of agents is the primary focus of T. W. Schultz's recent inquiry (1971, pp. 217-246), so that in one sense this section supplements his work by dealing with the aspect that he does not directly consider.

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[8] Defense research performed by industry is very large, accounting for 30 percent of all R+D expenditure.

[9] NSF, Federal Support to Colleges and Universities, pp. 7, 38. See also S. Harris et al. (1965), p. 87.

Expected Growth and Externalities

Increased satisfactions, and their distribution, have been expressed in a modified welfare function (or democratic state preference function) as follows:[10]

$$(1) \quad W_T = f\left[\sum_{k=1}^{n} g_{kt} Y_{kt}\right], \qquad t = T,..,L.$$

Research is expected to yield future returns in the form of real private income Y_t for many families in the electorate over periods T + 1,..,L. It is also expected to yield social benefits shared by all and expressed in f. The distributional impacts of the private benefits from the research (e.g. sickle cell anemia v.s. cancer research) appear in the g_{kt} weights. Also weights favoring the end of a longer planning horizon would tend to favor basic rather than applied research.

Current resources constrain the amounts available for research of all kinds. This assumes restrictions on borrowing. Borrowing for this purpose, for example, is restricted by borrowers risk because returns to basic research involve long run social benefits that are quite uncertain. The constraint also assumes fixed tax shares,[11] so that total tax receipts which most directly constrain investment in research are in turn a function of personal income. Under these assumptions, federal investment in the creation of new knowledge through research, I_{Rt}, is ultimately a function of current real personal income, Y_t, as shown in equation (2) below.

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[10] See Chapters 4 and 5.

Since advances in knowledge are a prime source of growth of future income (Y_t, $t = T + 1, .. L$), desired investment in research may also be hypothesized to be a positive function of these expected net returns. The desire for normal growth will be measured by the gap between the desired rate of economic growth (taking the desired rate $g^* = 4.2$ percent, a sustainable rate), and the actual growth rate g, or $(g^*-g)_{t-1}$. This ignores efforts to raise the sustainable rate g^*. This much, however, can be set out as the first two terms in a linear first approximation:

$$(2) \quad I^*_{Rt} = \alpha_1 Y_t + \alpha_2 (g^*-g)_{t-1} + \alpha_3 W_{t-2} + \alpha_4$$

W_{t-2} seeks to reflect intensification of the reach for growth, defense, and national power. It is a dummy variable that switches to unity following sputnik at the time the military-space technology race began. It is intended as reflecting the element of joint demand between demands for research and desires for defense or national power.

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[11] Equal proportional sacrifice is probably a more accurate characterization of our entire current federal tax system than is equal marginal sacrifice (i.e. minimum aggregate sacrifice).

Stocks of "Disembodied" Knowledge

It is possible to conceive of a stock of knowledge created by research of all kinds (S_{Kt}). It resides primarily in major libraries and materials in print. Its existence is distinct from attempts to embody this knowledge in persons, which is the role of investment in education.

Investment in research is an attempt to increase this stock of "disembodied" knowledge. It is useful to define new research in relation to the portion of the stock of existing knowledge that has been created by research as follows:

$$(3) \quad I_{Rt} = [S_{Kt} - (1-\delta)\, S_{Kt-1}]$$

Specific investment in research such as for example the large scale Manhattan Project to develop the atom bomb in World War II, or the investment needed to place a man on the moon, can be regarded as investment designed to close a gap between actual knowledge $(1-\delta)\, S_{Kt-1}$ and some specific desired level S^{*}_{Kt}. But although frequently only part of the adjustment occurs in any one year, this has not contributed to significant short run cyclical volitility in investment in federal support of university-based research as may be seen in Figure 1. Contracts once made normally are carried to completion. This weighs against postulating a stock adjustment process as a central element in the analysis of demand, although not against defining research in relation to the stock of knowledge as a useful organizing concept.

Storage of this existing stock of knowledge (S_{Kt}) in libraries, and minimizing its loss through depreciation (δ) do constitute an important social concern, however. The Education Amendments of 1972 authorize the following appropriations for libraries, for example:

Table 2. Appropriations Authorized for Libraries
(in millions of dollars)

	1972	1973	1974	1975
A. College library resources	$ 18	52.5	59.5	70
B. Library training and research	12	22.5	25.5	30
C. Library of Congress	9	12	15	19

Obsolescence differs from depreciation in that it may be a positive function of new research. S. Rosen (1971) has suggested that the rate of obsolescence of scientific knowledge is quite high, although it is obsolescence of knowledge after it has been embodied in educational capital that he speaks of (i.e., of $(1-\delta)\ S_{Et-1}$). He does not explicitly relate this rate to investment in new research.

But disembodied knowledge presents formidable measurement problems, even if it were to be measured at original cost. Much knowledge is created in other countries, it is heterogeneous, and obsolescence rates are more easily conceived of in relation to embodied knowledge. For these reasons it is best to omit S_{Kt-1}, from regressions while retaining the focus on investment in research as an explicit effort to add to the stock of existing knowledge.

III. EMPIRICAL TESTS OF INFLUENCES ON INVESTMENT IN RESEARCH

These major influences on real federal investment in research at institutions of higher education in equation (2) are tested using time series data in Table 3. Investment in research performed at public universities, colleges, junior colleges, and all public institutions combined is considered by regression equations (4) - (7), and (8) - (11) deal with comparable types of private institutions.

The main results are, first, that federal investment in research at all types of higher educational institutions does depend significantly on growing real income. This is consistent with the hypothesis that research is a normal public good, and with the higher secular income elasticity noted earlier. Second, the financial support for research also depends significantly on the excess of desired over actual growth rates, at least at universities. Third, W'_{t-2} as an index of efforts to advance military and space technology turned out to be a less important factor than might have been expected.

Emphasis should be placed only on those regressions in Table 3 dealing with research at public and private universities where almost all of the organized research is conducted. The statistical properties of these two equations (i.e. (4) and (8)), are quite good. It does seem reasonable that desired growth and the military-space race drop away as positive influences on research effort at four year colleges and junior colleges. Beyond this point, the equations dealing with research at junior colleges and at private four year colleges (6), (9), and (10) are best ignored. Research at junior colleges was practically nonexistent prior to 1966, and the data series underlying equation (9) contains some unexplained statistical properties.[12]

The rho coefficient is positive, and $\rho = .33$ to $.36$ in the university research equations. There is the likelihood of a positive feedback effect from investment in graduate education that makes larger numbers of skilled research workers able to do research available, a feedback effect that has not been taken into account. The statistics are bad on investment in graduate education, but there is a clear upward trend in the number of persons in the population as measured by Census estimates with five or more years of college

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[12] Several explanatory variables were tried that did not work out and are not discussed here. Most notably $^{G}T/G$, or federal transfer payments as a percent of the total budget as an index of social, as distinguished from defense, concerns, was tried but was never significant.

Table 3. Investment in Research at Institutions of Higher Education by the Federal Government, 1946-68
(t-statistic in parentheses below each coefficient; significant coefficients are underlined)

Investment I_R (Dependent variable)	Real personal income Y_t	Gap, desired over actual growth rate $(g^* - g)_{t-1}$	National power (military space race) W'_{t-2}	Constant term	ρ	R^2_ε (after ρ) SE_ε
(4) Public universities (R^2_u = .960, SE_u = 66.26) DW = 1.90	.0032 (12.13)	19.52 (2.59)	85.71 (1.74)	-846 (-8.59)	.36	.981 45.82
(5) Public 4-year colleges (R^2_u = .429, SE_u = 24.74) DW = 1.75	.0004 (5.43)	1.02 (.96)	a	-150 (-.374)	.85	.955 6.92
(6) Public 2-year colleges (R^2_u = n.a., SE_u = 42.80) DW = .85	.0001 (3.26)	.20 (.74)	a	b	1.01	.846 2.01
(7) Public total (R^2_u = .954, SE_u = 79.15) DW = 1.90	.0035 (10.90)	18.81 2.11	80.32 (1.38)	-968 (-7.69)	.46	.980 52.44
(8) Private universities (R^2_u = .954, SE_u = 55.30) DW = 1.82	.0024 (10.40)	14.69 (2.16)	70.51 (1.58)	-638 (-7.33)	.33	.973 42.14
(9) Private 4-year colleges (R^2_u = n.a., SE_u = 735.) DW = .68	-.0011 (-1.64)	-2.67 (-.53)	66.02 (1.86)	1,181 (2.07)	.96	.937 33.85
(10) Private 2-year colleges (R^2_u = .850, SE_u = .326) DW = 1.41	.0001 (9.57)	.055 (1.79)	a	-3.20 (-6.86)	.62	.955 .179
(11) Private total (R^2_u = .365, SE_u = 303) DW = 1.06	.0018 (5.15)	2.53 (.29)	a	b	.94	.969 66.89

Sources: Appendices A and C.

a. W'_{-2}, the least significant variable, was dropped before the equation was reestimated.

b. The constant term was not significantly different from zero and was suppressed.

education. Increasing the numbers of persons with advanced training certainly operates to restrain increases in cost, and also the capacity to do effective research. Perhaps since $\rho = .36$,

(12) $(.36\, u_{t-1} + \epsilon_t) = (.36\, (1-\delta)\, S_{EGt-1} + \epsilon_t)$

where S_{EGt-1} is the stock of post-graduate education.

IV. A MODEL WITH INTERDEPENDENCE BETWEEN HIGHER EDUCATION AND RESEARCH

It has been suggested above that investment in higher education depends in part on new higher return opportunities to invest, using the new knowledge created by research. Similarly, investment in research is only practicable by using human resources created by investment in higher education.

This suggests the joint dependence of investment in higher education and investment in the creation of new knowledge through research (I_{Rt}). Its essence is shown in (4), (5), and (6), combined with the joint dependence of investment in research on investment in newly created educational capital in (7):

(4) $I_{HHt} = f_4\, (\ldots,\, I_{Rt})$

(5) $I_{S+Lt} = f_5\, (\ldots,\, I_{Rt})$

(6) $I_{Ft} = f_6\, (\ldots,\, I_{Rt})$

(7) $I_{Rt} = f_7\, (\ldots,\, (I_{HHt} + I_{S+Lt} + I_{Ft}))$

This simultaneous equation model therefore links the investment in research considered in this chapter to the investment in higher education considered in Chapters 3 - 5. Using the main results drawn from chapters 3 - 6, the joint dependence of education and research is tested in the estimates made

Table 4. The Joint Dependence of Investment in Education and Research
(t-statistic is shown below each coefficient in parentheses; millions of constant (1958) dollars)

Investment in:	Current income	Young adults (C_{18-26}) or veterans (V)	Desired growth (Y_{Bt}, g^*) or equity (g_k)	Constant term	Investment in research, education
(8) Higher education, households =	.032 Y_t (7.83)	+54456 C_{18-26} (7.67)		-12360 (-7.21)	+2.53 I_{Rt} (5.05)
(9) Higher education, state and local =	.013 Y_t (11.37)	+21074 C_{18-26} (8.50)	+5721 g_k (2.79)	-7988 (-7.14)	+1.778 I_{Rt} (1.55)
(10) Higher education, federal =	.009 Y_t (4.61)	+.039 V_t (7.76)	+.027 Y_{Bt} (.53)	-779 (-1.49)	+.112 I_{Rt} · -13.7 $(1-\delta)S_{Et-1}$ (.93) (5.04)
(11) Research[a] =	.003 Y_t (1.08)		+19.64 $(g^*-g)_{-2}$ (1.06)	-1214 (-1.49)	+.756 $(I_{HH}+I_{S+L}+I_F)$ (1.45)

Definition of variables and sources of data: See Appendix A.

[a] Research in (11), and in (8), (9), and (10), was deflated with the Personal Consumption Expenditures deflator (as were all other economic variables), in contrast to the FPGS deflator used earlier in this chapter. Switching to the latter would very possibly cause the significance of Y_t and $(g^*-g)_{t-2}$ in (11) to conform more closely to earlier results.

by restricted three stage least squares that are presented in Table 4. The coefficients of I_{HHt}, I_{S+Lt}, and I_{Ft} are restricted to equal one another as shown in (7) above.

The significance of both current income and young adults (or veterans) holds up in these simultaneous equation estimates. The positive and usually significant coefficients for investment in research are consistent with the hypothesis that new research does create new investment opportunities, for households (see also p. 3-19) and for state and local governments (see also p. 4-20) at least. It is not important in the equation explaining federal investment in higher education. Investment in higher education makes a less satisfactory addition to the research equation (11); when it is introduced it substitutes in part for highly significant income and desired growth effects.[12]

We may conclude that this source of simulteneity does not disturb any of our other results. Also there is some limited evidence consistent with the proposition that investment in research does create new educational capital investment opportunities.

V. SUMMARY OF CONCLUSIONS

Research in institutions of higher education supported by the federal government is concentrated in a few universities. It is dependent upon real income growth, and exhibits a very high gross secular income elasticity.

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[12] When the number of persons in the population with 5 or more years of higher education was substituted for this recent investment, it together with current income was highly significant.

Research simultaneously contributes to advances in knowledge, and through this to growth. Because its relation to growth is widely recognized, it may sometimes be called upon (e.g. in the 60's) to increase growth. But this effect if it exists is weak.

The measures of the effect of intensified demands for military-space technology that were tried did not prove significant. However, the most recent NSF data for total R+D support to all universities is as follows:[13]

1968	$1,398
1969	1,475
1970	1,447
1971	1,554.

Research displays a flattening out for 1968-1972, especially in 1970 which saw the beginning of the end of the space race, Viet Nam and campus disturbances, and was also a recession year. But the last two of these factors are both transitory, and are apt to be less important in the long run than the continuing growth of real income.

Finally there is some limited and tentative evidence of interdependence between investment in higher education and investment in research. Research creates new knowledge that generates obsolescence of some existing knowledge, and hence of some human capital, while at the same time creating opportunities to invest profitably in new educational capital. There is some suggestion that the latter are seized upon primarily by households. As post-secondary educational opportunities are opened up to students from low income families in the new phase being faced by higher education, this contribution from research has the potential at least of preventing diminishing returns to educational capital.

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[13] Unpublished data supplied by the Universities and Non-profit institutions Studies Group, Division of Science Resources Studies, National Science Foundation. The total is for all institutions, but does not include NIH programs that NSF classifies under "Other science activities."

Chapter 7

Summary and Conclusions

Higher education has been viewed in a new light in this study, with the household regarded as the basic producer of educational capital. This is important, for the family not only provides the emotional support and offers a model for guidance with greater or lesser efficiency from preschool through graduate school years, but it also provides the bulk of the investment.

Higher educational institutions fill a necessary supporting role by supplying formal education inputs. Governmental institutions also support the process by correcting underinvestment (or overinvestment) and furthering equity. Research has a key role in the creation of new knowledge that offers (and finds) new high return opportunities for investment in educational capital, countering the onset of diminishing returns to this type of investment.

I. MAJOR FINDINGS

It is a basic result that investment in higher education turns out to be a positive function of current personal income, not only for households, but also for state and local governments and for the Federal Government. This result, at least for households, is intuitively obvious and frequently alluded to, but others have not specifically worked it out. This study develops an analytical model of the family's life cycle in Chapter 2, and of public expenditure decisions in Chapters 4 and 5, that explain why it is so. Current resources are empirically more important than expected future earnings in all cases, including investment by families in tuition and fees and foregone earnings at public or private institutions (p. 3-14), by state and local governments, or by the Federal Government at universities, four year colleges, or junior colleges (p. 5-16). Most investigators would accept the influence of income on investment in education as reasonable, and many have mentioned it almost in passing (together with the feedback, but non-simultaneous, effect of education as one among several contributors to economic growth). But the analytical models presented here, as well as the regressions, give the effect of income the central role as well as statistical and analytical backbone.

The income elasticities of investment-demands for research are even higher than they are for post-secondary education. Together with the preceding income effects on education, this suggests that in a growing economy post secondary education can be expected to continue to expand, and an even more accentuated expansion of research will be available as an offset to diminishing returns.

The number of young adults in the college age bracket is the second most important determinant of all types of investment in higher education by households (p. 3-16) as well as by state and local governments (p. 4-22). It is replaced by a four year moving total of recently discharged veterans as the second most important determinant of federal investment. The graduation from college of those who were part of the post World War II wave of births, and the recession-related decline in income, operated to curtail finances at public and private institutions alike in 1971 and 1972. This should ease (and job markets should improve) as recovery continues. But educational planners would do well to use income and demographic projections together to avoid the teacher gluts now apparent in the grades.

Other variables are more marginally significant in specific situations. High long run interest rates have been negatively related to investment by households at private institutions (p. 3-18). Rising private school tuitions have increased revenues at these institutions from families (p. 3-18) suggesting inelastic demands perhaps made more inelastic by easing restrictions on admissions. There is some evidence of a negative short term reduction in public sector investment when existing stocks of educational capital get high (pp. 4-22, 5-16). But this is often accompanied by a positive trend that has been removed from the residuals, a trend that tentively has been interpreted as a creation of new investment opportunities through research. Data has been developed on research expenditures at different types of universities (Appendix C) which reveals that the high secular income elasticity mentioned above is sometimes accompanied by some response of rates of investment in research to deviations between actual and desired rates of growth.

The limitations to time series analysis are well recognized. But they do reveal effects that can be revealed in no other way, and suggest hypotheses for further testing with microeconomic data. Such tests are in process, especially as they pertain to production-investment decision making by individual families.

II. GROWTH, STABILITY, AND EQUITY

The Education Amendments of 1972, summarized in Chapter 5, may well be as important if not more important in their impact in the long run on higher education in the United States as was the Land Grant Act of 1862. The Land Grant Act extended post-secondary education to the sons of farmers and to children from middle income homes, creating new curricula in agriculture, engineering, and business in the process. The Education Amendments of 1972 undertake to extend post-secondary educational opportunity to students from low income families.

This act presents many challenges, not the least of which lie in the imginative testing of workable curricula and in the administration of the act so that it effectively aids those with greatest need. The half-cost provision (p. 5-8), for example, will divert large amounts of the money appropriated toward aid toward the high cost private schools. Private institutions are infrequently strongly church related now, and do deserve some public support. They have felt financial pressures recently similar to the falling revenue receipts per student that have troubled the public institutions. These pressures have been rooted primarily in the slower rates of growth of endowment fund income (p. 4-3) which therefore needs to be supplemented. But the high tax cost of excessive use of this channel as a means of extending educational opportunity (because of the high per student cost in private institutions) needs to be taken seriously into account.

I conclude that the crisis in educational finance facing public and private institutions alluded to in the introductory chapter is essentially a passing fluctuation, for there are several very strong undercurrents of long run growth. Adjustments need to be made to periodic slowdowns in the rate of increase in the numbers of young adults in the oncoming college generations. But there are important effects from rising income, the gradual extension of post-secondary education to low income homes, and the creation of new knowledge by research to dictate a slower but continuing expansion.

The challenges, however, remain very real. Some of these are related to the revolution that is underway in the subject of educational finance. As basic social science disciplines are brought to bear on the problems of education, whole new ways of looking at and doing things that go beyond narrower efforts to do old things better are increasingly likely to emerge. In addition to the current attention being given to cutting costs, I should like to summarize three possibilities developed in more detail in the text.

First, there is the broad challenge of improving investment decisions, and through this the allocation of resources, toward the end of achieving humane growth. This involves locating where there is underinvestment by families while using a broader criteria of monetary plus non-monetary (and private plus social) returns, then taking steps to increase investment at those points. If there is overinvestment elsewhere, it should be curtailed. Calculating more broadly conceived rates of return, and finding out where they are highest in both education and research are two very large and difficult tasks. Important contributions are being made to this by T. W. Schultz (1971) (1972), the NRC Panel on the Benefits of Higher Education, and others. Two very limited aspects of the former are the incorporation of non-monetary private benefits in the analysis of family decision-making that has been offered in Chapter 2, and the incorporation of social benefits in the model of public decision-making offered in Chapter 4. But there is much to be done in merely calculating the contribution of various education and research inputs to measured growth.

Second, there is the specific challenge of utilizing the continuing expansion of junior college enrollments to help stabilize the high 13-18 percent unemployment rates among young adults age 17-20 during recessions.

Specific suggestions have been made as to how this might be done by use of the "supplemental economic opportunity grants" in Chapter 5 (p. 5-23). The release of larger numbers of more skilled persons onto labor markets during periods of overfull employment then would help stabilize further by easing shortages and aiding productivity during the periods when the most help is needed toward easing inflationary pressures.

Third, there is the challenge of securing equity in access to educational opportunity for each new generation. I have made specific suggestions relating to the importance of modifying the half-cost provision and more fully funding the basic and supplemental economic opportunity grants in Chapter 5. There is also the debate over low public school tuitions. It has proceeded without much reference to the out-of-pocket room and board costs, or the total stock of educational capital. The issue involves competitive relationships between the public and private sectors to which there is little to add. Low cost junior colleges also compete with the senior public institutions as they lower out-of-pocket room and board costs. But it is not just the growth of educational capital stocks which low tuitions encourage, but also the influence of government as it extends higher educational opportunities to the poor, that operate toward reducing the inequality in the personal distribution of income in the next generation.

Vertical equity in benefits is also a challenge because its success depends on recognition of the different characteristics of students that come from poor urban families. This in turn is based on understanding the process of production of educational capital by households (p.2-5).

Finally, there is the challenge offered by the need for a more coherent national higher education policy. There is the need for focus on the concept of investment in educational capital as an organizing concept, for collection of the widely scattered data sources involving the largely uncoordinated higher education programs administered separately by the Veterans Administration, Social Security Administration, Department of Defense, NSF, Department of Labor, and Health, Education and Welfare, and for reduction of the appalling four year lag in the publication of basic data. The Commission on the Financing of Higher Education has a broad mandate in the Act, as discussed in Chapter 5, and hopefully will not confine its attention to narrow partisan issues. The present state of affairs is a mixture of pressure group special pleadings, and of relatively limited hard research by economists, educational psychologists, and specialists from other "outside" basic disciplines that is so vital to the development of new approaches. A more coherent education-economic policy centered on investment in educational capital should also pursue and extend the specific suggestions made above relating it to broadly held goals of growth in income and real satisfactions, minimization of inflation and unemployment, and intergenerational equity.

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Appendix A

List of Variables and Data Sources

Source notes cite items by year in the preceding list of Government Documents and Related Data Sources. Numbers in parentheses other than years are keys to variable numbers in the computer data bank. Variables in real terms are deflated using the Personal Consumption Expenditures implicit deflator unless indicated to the contrary.

$q_{Pub.}$ = enrollment in all public institutions of higher education (828), in public universities only (613), 4 year colleges (615), and 2 year colleges (692).

$q_{Pvt.}$ = enrollment in all private institutions of higher education (829), in private universities only (614), 4 year colleges (616), and private 2 year colleges (693).

Source: 1929-54 U.S.O.E. (1962) Biennial Survey of Education
1955-72 U.S.O.E. (1972) Opening Fall Enrollments in Higher Educational Institutions.

$p_{Pub.}$ = full cost (price) per student at public institutions in constant 1958 dollars. For universities, 4 year, 2 year, and all public institutions in each case below.

p_{T+F} = tuition and fees per student at public institutions ($p_{T+F}q_{Pub}/q_{Pub}$)

p_{S+L} = state and local support per student ($p_{S+L}q_{Pub}/q_{Pub}$)

p_F = federal support per student (p_Fq_{Pub}/q_{Pub})

p_G = gifts and endowment income per student (p_Gq_{Pub}/q_{Pub})

$p_{Pvt.}$ = full cost (price) per student at private institutions in constant 1958 dollars. For universities, 4 year, 2 year, and all public institutions in each case below.

p_{T+F} = tuition and fees per student at private institutions ($p_{T+F}q_{Pvt}/q_{Pvt}$)

p_{S+L} = state and local support, private, $(p_{S+L}\, q_{Pvt}/q_{Pvt})$

p_F = federal support per student $(p_F q_{Pvt}/q_{Pvt})$

p_G = gifts and endowment income per student $(p_G q_{Pvt}/q_{Pvt})$

Source: See sources for investment expenditure below.

$I_{Pub.}$ = total investment in higher education at public institutions, total and major components in millions of constant (1958) dollars, P.C.E. deflator.

I_{T+F} = $p_{T+F}q$ = total real investment by households through tuition and fees at public institutions (806).

I_{S+L} = $p_{S+L}q$ = total real investment by state and local governments at public institutions (701) composed of investment at public universities (698), public four year colleges (699), and at public two year junior colleges (700).

I_F = $p_F\, q$ - total federal investment in education (976) (separation of research in appendix C, and see $p_{FV}\, q_{Pub.}$ below) composed of investment at public universities (970), at four year colleges (972), and two year junior colleges (974), excluding contract research

$p_G\, q$ = total real investment from gifts and endowment income at public institutions (931) composed of investment at public universities (933), at four year colleges (935) and at two year colleges (937).

$I_{Pvt.}$ = total investment in higher education at private institutions, total and all major components in millions of constant (1958) dollars, P.C.E. deflator.

I_{T+F} = $p_{T+F}q$ = investment by households through tuition and fees at private institutions (807).

I_{S+L} = $p_{S+L}q$ = total state and local investment at private institutions (753), at private universities (750), at private four year colleges (751), and at private two year colleges (752).

$I_F = p_F q$ = total federal investment in education (see separation of research in Appendix C) at private institutions (977), at private universities (971), at private four year colleges (973); and at private two year colleges (975). See also $p_{FV}q_{Pvt.}$ below.

$p_G q$ = total gift and endowment income of private institutions (932), private universities (934), private four year colleges (936), and private two year junior colleges (938).

Source of all investment expenditure data above is: 1929-1969 U.S. Office of Education (1962) Biennial Survey of Education, Chapter 4, "Statistics of Higher Education," after which its name was changed to U.S.O.E. (1973) *Financial Statistics of Institutions of Higher Education,* "Current Funds Revenues and Expenditures." The concepts are those in Table 3 of each issue. Specifically 1927: pp. 34, 40, 1929: pp. 54-5, 1931: pp. 32-3, 1933: pp. 38-9, 1935: pp. 40-1, 1937: pp. 50-1, 1939-41: pp. 38-9, 1943: p. 42, 1945: p. 48, 1947: p. 58, 1949: p. 36, 1951: p. 48, 1953: p. 10, 1955: p. 10, 1957: p. 8, 1959: p. 12, 1961: p. 34, 1963: p. 4, 1965: p. 11, 1966: p. 14, 1967: pp. 12-13, 1968: p. 16, 1969: unpublished data supplied by C. George Lind of the National Center for Educational Statistics. For I_F see also Appendix C.

$I_{HH\ (Pub.)}$ = total real investment by those households using public institutions, in millions (808)

$p_{T+F}\ q$ = tuition and fees at public institutions (806) same as above.

$p_{R+B}\ q_{Pub.}$ = room and board public institutions (746)

$p_{EFE}q_{Pub.}$ = excess foregone earnings beyond room and board costs (800)

$p_{FV}q_{Pub.}$ = veterans' and social security dependents' benefits paid to households by the Federal Government, included in $p_{T+F} + p_{R+B}$ above.

$I_{HH(Pvt.)}$ = total real investment by those households using private institutions, in millions of constant (1958) dollars, P.C.E. deflator,(809)

$p_{T+F}q$ = tuition and fees at private institutions (807) same as above

$p_{R+B}q_{Pvt.}$ = room and board at private institutions (804)

$p_{EFE}q_{Pvt.}$ = excess foregone earnings beyond room and board costs (805),

$p_{FV}q_{Pvt.}$ = veterans' and social security dependents' benefits, in $p_{T+F}+ p_{R+B}$.

Sources: $p_{R+B\ Pub.}$, $p_{R+B\ Pvt.}$, and combined out-of-pocket price indices from:

1929-1964, E. D. West et al., p. 38, and

1965-1972, U.S.O.E. (1971) Projections of Educational Statistics

$p_{EFE}q_{Pub.}$ and $p_{EFE}q_{Pvt.}$ are computed by adjusting real average weekly earnings in manufacturing (from the Statistical Abstract) for a 25 week school year by employment rates. The resulting foregone earnings per student is multiplied by public and private institution enrollments respectively. Room and board is then subtracted to get the excess foregone earnings residual.

$I_{R\ Pub.}$ = Total Federal Expenditures on Research at Public Institutions of Higher Education (859) in constant (1958) dollars; all deflated by federal purchases of goods and services deflator.

investment at public universities (678)

public four year colleges (680)

public junior colleges (682)

$I_{R\ Pvt.}$ = Total Federal Expenditures on Research at Private Institutions of Higher Education (860) in constant (1958) dollars; all deflated by federal purchases of goods and service deflator.

investment at private universities (679)

private four year colleges (681)

private junior colleges (683)

Source: Appendix C.

S_{Et-1} = the stock of higher educational capital measured at original cost (922). Source: See Appendix B.

S^c_{Et-1} = the stock of higher educational capital measured as the number of persons age 25 and older with 1-3, 4, or over four years of college (628). Source: U.S. Bureau of the Census, Current Population Report, Series P-20, Nos. 6, 15, 99, 121, 138, 158, 169, 182, 194, 207.

Y_D = real disposable personal income (312), Source: Office of Business Economics (1972), National Income and Product Accounts

Y_t = real personal income (308), Source: ibid.

Y_t^e = expected real disposable personal income for years $t = T+1,..L$. Rather than using a distributed lag on past income, this was measured directly by an index of income expected in the future in relation to current income as of February each year as reported to Michigan Survey Research Center interviewers, computed as the net percent of expecting an increase (501), Sources: 1946-1959 March Federal Reserve Bulletins (1973) (e.g. 1959, p. 253), 1960-1969 Survey of Consumer Finances, Michigan Survey Research Center.

Y_{Bt}^e = average annual expected real personal income of persons with a bachelor's degree, less that expected by a high school graduate (959). Expectations are measured based on the hypothesis that they reflect current actual income differentials. Source: (of actual differentials) for 1946-70 is U.S. Bureau of the Census (1972) Statistical Abstract of the U.S. 1939, 1946 are in 1962 issue, p. 119; 1949, 1956 in 1970, p. 111; 1965, 1966 in 1968, p. 112; 1967, 1968 in 1970, p. 111; 1969, 1970 in 1972 issue. See also AER, December 1960.

C_t = young adults of college-eligible age as a percent of the population; upper age allows for graduate school, lower for state planning.

C_{18-26} (706), (718) for total investment by households, including returning veterans,

C_{16-26} (861) for state investment at universities,

C_{16-22} (862) for state investment at four year colleges,

C_{16-20} (863) for state and local investment at junior colleges.

Source: U.S. Bureau of the Census (1972), Current Population Reports, Series P-25, Nos. 311, 314, 385, 416, 441, and 448.

S_{Pt-1} = psychological stocks of tastes and habits for higher education, measured as the number of persons (parents) ages 35-64 who have completed 4 or more years of college (621 + 622 + 624 + 625 + 628 + 629).

Source: U.S. Bureau of the Census (1972), Cur. Pop. Rep., Series P-20.

g_k = Gini coefficient of inequality in the distribution of income (856), calculated by quintiles. Sources: 1929-1963 H. Miller, Income Distribution in the U.S., p. 21, 1964-1970 U.S. Bureau of the Census, Current Population Reports, Series P-60, No. 80, p. 28.

g_t = actual growth rate of real Gross National Product (695).

Source: A five year moving average of annual percentage increases in real GNP as calculated from the U.S. Office of Business Economics (1972) National Income and Product data. The average is computed for years T-3 through T+1 to apply to the current year T.

δ = obsolescence rate (which in Chapter 2 includes depreciation from retirements and death) applying to the stock of educational capital. This is estimated as part of the regression coefficient $\theta(1-\delta)$ from the data.

ρ = a regression coefficient measuring autoregression in the residuals by a first order autoregressive scheme. ρ is postulated to be a crude measure of the stimulus to investment provided by new knowledge created by the upward trend in resources devoted to research.

ss_1 = percent of the household's total educational capital stock (i.e., of its total time) devoted to the production of educational capital

$(1-s)s_1$ = percent of the household's total stock (time) devoted to work

$1(1-s_1)$ = percent of the household's total stock (time) devoted to sleep and leisure

w = index of faculty salaries, non-faculty salaries, and the price of supplies and services purchased by educational institutions.

Sources: Weights of .43 for faculty salaries, .28 for non-faculty salaries, and .29 for the price of supplies and services are from J. D. Millett, Financing Higher Education in the U.S.

1929-1967 data from J. O'Neill (1971), p. 81

1967-1971 Faculty Salaries from AAUP Bulletin, June 1971, p. 240

Non-Faculty from U.S.O.B.E. (1972) July 1971, p. 36

Price of supplies uses the Wholesale Price Index for fuel, paper, and paint, from ibid.

1972-1980 After conversion to 1958 base, indices were projected to 1980 based on growth rates of comparable deflators as predicted by the DRI econometric model.

r = long term real interest rate (345). Measured as the interest rate on new first mortgages deflated by the Personal Consumption Expenditures implicit deflator.

Source: 1929-47 Morton, Urban Mortgage Lending, p. 173

1948-72 Economic Report of the President

1973-80 As predicted by DRI model.

V_t = change in the number of veterans under age 35 in civil life, a four year moving total (827).

Source: 1929-1955: Historical Statistics of the U.S., Series Y787-800, p. 738, 1956-1969 U.S. Bureau of the Census (1972), Statistical Abstract.

Q_{Et} = gross additions to the stock of educational capital produced through higher education (See I_{HH}).

P_{Et} = shadow price of Q_{Et} to households (See p_{T+F}, P_{R+B}, and P_{EFE} under I_{HH} above)

D = control by Democratic Party (822). A dummy variable; D = 1 in years Democrats control both executive and legislative branches, D = 0 in years they control none or one branch only. Source: Statistical Abstract.

R = control by Republican Party (823). A dummy variable; R = 1 in years Republicans control both executive and legislative branches, R = 0 in years they control none or one branch only. Source: Statistical Abstract.

N = percent of labor force employed (612). For example, for 5 percent unemployment, N = 95.0. Source: U.S. Executive Office of the President (1973), Economic Report of the President.

$(g^*-g)_{t-1}$ = the gap between the desired (or sustainable) rate of economic growth and the actual rate (941). The latter is measured as a moving average of the actual rate over the preceding five years. Specifically $(4.2\%)-(g_{t-3}) = 4.2 - (695)_{-3}$.

W = Wartime dummy variable intended to reflect, in part, greater external threats. $W = 1$ for war years, $W = 0$ for non-war years (690).

W_{t-2} = Post-Sputnik period (1001). A special emphasis on both space research and military preparedness occurred that was strengthened by the Viet Nam escalation. A dummy variable with $W = 0$ for 1946-62, $W = 1$ for 1963 onward.

Appendix B

Annual Data on the Stock of Educational Capital, 1928-72

Estimates of the total stock of educational capital in the United States 1928-72 that was created by formal education were constructed based upon the real costs in 1958 dollars of the resources invested in primary, secondary, and higher education. These costs include the tuition and fee, tax, and gift supported costs of the institution-controlled resources used for instruction, the earnings foregone by students, expenditures on books, expenditures on school supplies, and commuting expenses. This Appendix reports the data, explains the methods by which they were constructed, and gives the underlying data sources.

The method employed in general is that developed by T. W. Schultz (1971) as reported in his Investment in Human Capital, Chapter 8. Therefore the results for 1928-1972 after allowance for the minor adjustments in concept appropriate to our purposes (described below) are directly comparable to T. W. Schultz's benchmark estimates for 1940 and 1957, but include the intervening years and extend the estimates through 1972. The method estimates the stock of educational capital as the annual real cost of education per person in 1958 dollars times the number of constant (equal length) school years completed by those members of the population aged 14 years old and over. This total stock of educational capital, S_{ETt}, which includes that formed through primary and secondary schooling, is shown in Table B-1 in Column 2 (for 1928-45) and Column 6 (1946-72). The latter is the product of Column 4 (average cost) and Column 5 (school years completed) which are shown separately for the postwar years.

Table B-1. Stock of Educational Capital, 1928-72 at Original Cost
(constant (1958) dollars)

Prewar years (1)	Stock of educational capital (billions of dollars) S_{ETt} (2)	Postwar years (3)	Cost in 1958 $ of one school year, average of all levels (Table B-3, Col. (8+9+10) ÷ (7)) (4)	Total constant school years completed (in millions) (5)	Total Stock of all educational capital (billions, 1958 $) S_{ETt} (6)
1928	188	1946	409	868	355
1929	195	1947	419	902	378
1930	201	1948	433	921	399
1931	210	1949	463	946	438
1932	218	1950	504	970	489
1933	226	1951	527	990	522
1934	235	1952	555	1,030	572
1935	243	1953	590	1,046	617
1936	251	1954	615	1,068	657
1937	260	1955	612	1,094	670
1938	268	1956	643	1,119	719
1939	276	1957	658	1,146	754
1940	285	1958	674	1,181	797
1941	296	1959	707	1,209	855
1942	308	1960	728	1,225	891
1943	320	1961	750	1,272	954
1944	331	1962	788	1,298	1,022
1945	343	1963	807	1,336	1,079
		1964	859	1,373	1,179
		1965	918	1,416	1,300
		1966	975	1,455	1,419
		1967	1,026	1,494	1,534
		1968	1,061	1,539	1,632
		1969	1,121	1,288	1,444
		1970	1,168	1,453	1,697
		1971	1,217	1,491	1,814
		1972	1,306	1,530	1,999

The only important difference between Schultz's data and the estimates derived in this Appendix is that T. W. Schultz (1971) measures the stock of educational capital embodied in the population as the product of the annual cost per member of the labor force (ibid. p. 128, Col. 2) and the total constant school years completed by the population (ibid., p. 126, Col. 4). The estimates presented here compute and use the average annual cost of education with respect to the population, rather than with respect to the labor force. This puts the results on a consistent basis. The educational capital stock formed by the entire population including housewives is society's total stock from the point of view of the analysis of decisions to invest, including investment in education for women. The result is that a more rapid growth of educational capital in the postwar years is revealed; S_{ETt} is 51 percent of Schultz's estimate in 1945 and grows to 91 percent of his estimate in 1957. It reflects the shift from low cost elementary schooling of homemakers and others who are included in the population but not in the labor force toward higher cost secondary and college training. The remaining difference is accounted for by the fact that Schultz's data are in 1956 rather than 1958 prices. The third and final difference is that our data are listed also by academic year but by the designation for the beginning rather than the ending half.

Other measures of the value of the stock of educational capital in terms of its marginal productivity (as measured by earnings under the assumption that labor is paid the value of its marginal product) are less relevant to a capital stock adjustment model on the grounds that human capital can not be liquidated by resale. However some way of taking depreciation and obsolescence of society's stock of educational capital into account (apart from mortality, which is taken into account) is a definate weakness of this original resource-cost measure of the size of the current stock.

Table B-2 shows the calculation of average annual resource costs of education in constant dollars, which is put on a per-student basis in Table B-3, columns 8-10, before being averaged for use in the calculation shown in Col. 4 of Table B-1. These average annual resource costs in Table B-2 include annual earnings foregone by high school and college students in the postwar years as shown in Columns 3 and 7. They were calculated by multiplying the 11 earning-equivalent weeks of high school students and 25 earning-equivalent weeks of college students, as discussed in T. W. Schultz (1971, p. 85), by the average weekly earnings of all manufacturing workers from the Historical Statistics of the United States, p. 92, Series D 626-34 and later issues of the Statistical Abstract. These measures of average weekly earnings were then adjusted for changes in the rate of unemployment taken from the Economic Report of the President. Next total foregone earnings adjusted for unemployment were obtained by multiplying these average weekly earnings by enrollment in secondary schools, as described in U.S.O.E., Digest of Educational Statistics, 1970, p. 27 and U.S.O.E., National Center for Educational Statistics, Projections of Educational Statistics to 1979-80, 1970 Edition, 1971, p. 20, and in colleges and universities as found in U.S.O.E., Biennial Survey of Education in the U.S., ch. 4, U.S.O.E., Opening (Fall) Enrollment in Higher Educational Institutions, and U.S.O.E., National Center for Educational Statistics, Projections of Educational Statistics to 1979-80, 1970 Edition, 1971, p. 23. Expenditures for books and other private expenditures such as commuting expenses shown in Columns 4 and 8 of Table B-2 are estimated as 5 percent of total foregone earnings at the secondary level and 10 percent at the college level

Table B-2. Total Annual Resource Costs of Education, 1946-75
(in millions of constant (1958) dollars)

Year	Elementary	Secondary				Higher			
	Total (1)	Institutional (2)	Foregone Earnings (3)	Other (e.g., Books) (4)	Total (2+3+4) (5)	Institutional (6)	Foregone Earnings (7)	Other (e.g., Books) (8)	Total (6+7+8) (9)
1946	4,082	2,346	4,094	205	6,644	1,708	2,515	252	4,474
1947	4,264	2,419	4,283	214	6,916	1,926	3,316	332	5,573
1948	4,568	2,547	4,455	223	7,225	2,223	4,138	414	6,775
1949	5,136	2,827	4,450	222	7,499	2,457	4,169	417	7,042
1950	5,725	3,096	4,830	241	8,167	2,622	4,490	449	7,561
1951	5,963	3,197	5,128	256	8,581	2,589	4,395	439	7,423
1952	6,438	3,421	5,450	272	9,143	2,689	4,225	423	7,337
1953	7,295	3,842	5,928	296	10,067	2,859	4,604	460	7,923
1954	8,341	4,354	5,976	299	10,629	3,052	4,651	465	8,168
1955	8,438	4,367	6,439	322	11,128	3,315	4,993	499	8,807
1956	9,291	4,765	7,137	357	12,259	3,597	5,175	518	9,289
1957	10,021	5,094	7,595	380	13,068	3,939	5,718	572	10,229
1958	10,714	5,397	7,579	379	13,356	4,299	5,744	574	10,618
1959	11,385	5,658	8,416	421	14,496	4,662	6,729	673	12,063
1960	12,196	6,007	9,000	450	15,457	5,088	7,185	718	12,991
1961	12,959	6,297	9,553	478	16,328	5,596	7,762	776	14,134
1962	13,907	6,696	10,635	532	17,863	6,180	8,775	878	15,832
1963	15,122	7,215	10,966	548	18,728	6,829	9,180	918	16,927
1964	16,474	7,788	12,149	607	20,545	7,601	10,848	1,085	19,534
1965	18,338	8,551	12,928	646	22,126	8,780	12,490	1,249	22,519
1966	20,096	9,284	13,603	680	23,567	9,736	13,677	1,368	24,781
1967	21,670	9,919	13,994	700	24,613	10,914	14,872	1,487	27,273
1968	22,694	10,244	14,750	738	25,731	12,167	16,471	1,647	30,286
1969	24,726	11,109	15,454	773	27,336	13,199	17,683	1,768	32,649
1970	26,266	11,746	15,659	783	28,188	14,590	18,174	1,817	34,582
1971	27,754	12,296	15,930	796	29,021	16,085	18,919	1,892	36,895
1972	30,201	13,254	16,753	838	30,845	18,326	20,322	2,032	40,680
1973	32,362	14,068	17,330	866	32,265	20,708	21,580	2,158	44,446
1974	34,502	14,786	17,735	887	33,408	23,347	22,437	2,244	48,028
1975	36,766	15,758	18,403	920	35,080	26,578	23,592	2,359	52,529

by Schultz (1971), p. 94, footnote 5 and p. 95, footnote 5. In general, years beyond the last year for which data is available (e.g., sometimes it was not yet available for 1972) are extrapolated on the basis of the previous 5 year average annual rate of growth.

The net institutional cost of public elementary and secondary schools shown in Columns 1 and 2 of Table B-2 then was estimated by first deducting capital outlays from gross expenditures (i.e., capital outlays, U.S. Bureau of the Census, Historical Statistics of the U.S. Colonial Times To 1957, p. 209; Research Division of N.E.A., Estimates of School Statistics, 1967-68, Research Report 1967-R 19, and gross expenditures, U.S. Bureau of the Census, Statistical Abstract of the U.S.,1952, Table 143 and later issues). Implicit interest and depreciation charges, calculated as 8 percent of the value of property (1929-58: U.S.O.E., Biennial Survey of Education in the U.S., ch. 2, Table 1 and 1959-67: U.S.O.E., Statistics of State School Systems) were then added to this net cost to obtain the total institutional cost of public elementary and secondary schools. This public total was then multiplied by the ratio of gross expenditures for private versus public elementary and secondary schools, (gross expenditures for private elementary and secondary schools are given by U.S. Bureau of the Census, Statistical Abstract of the U.S., 1952, Table 143 and later issues). This yielded an estimate of the total institutional cost of private elementary and secondary schools. Next, these public and private totals were combined to obtain the overall institutional cost of all elementary and secondary schools. The overall total was then allocated between elementary and secondary schools in the same proportion as estimated by Schultz (1971), p. 91, Table 6.3, Col. 9, 10, 11.

The total institutional cost of colleges and universities shown in Column 6 of Table B-2 was estimated as the sum of implicit interest and depreciation charges, calculated as 8 percent of the value of property, U.S.O.E., Historical Statistics of the U.S., Colonial Times to 1957, p. 213; U.S.O.E., Higher Education Finances, Selected Trend and Summary Data, 1968, p. 3, and U.S.O.E., Financial Statistics of Institutions of Higher Education: Property, 1965-66, p. 27, and later issues, plus current income used for instruction. The latter is from the following sources: for state and local governments, and the Federal Government, U.S.O.E., Biennial Survey of Education in the U.S., ch. 4, U.S.O.E., Financial Statistics of Institutions of Higher Education: Current Revenue and Expenditures, 1960, p. 12 and later issue's for tuition and fees, Ibid., p. 15 and earlier issues; and for endowment earnings, private gifts and grants, organized activities related to instructional departments, and miscellaneous activities, U.S.O.E., Historical Statistics of the U.S., Colonial Times To 1957, p. 212, Series H 339-350 and U.S.O.E., Statistical Abstract of the U.S., 1962, p. 132 and later issues.

The total adjusted earnings foregone by high school and college students plus their expenditures for books and for commuting were added to the respective total institutional costs at each level as shown in Columns 1, 5, and 9 in Table B-2. These costs and the institutional costs of elementary schools have been converted to 1958 dollars using the Personal Consumption Expenditure Implicit Price Deflator, U.S. Office of Business Economics, National Income and Product Accounts of the U.S., 1929-65, 1966 Supplement to the Survey of Current Business, p. 162, and later July issues, and U.S. Office of Business Economics, Survey of Current Business, Sept. 1971, p. 13.

Table B-3. Annual Cost of Education per Member of the Population Aged 14 Years and Over, 1946-75
(in constant (1958) dollars)

Year	Annual Cost per Student*			Median School Yrs. Completed, Pop.				Annual Cost per Person		
	Elementary (1)	Secondary (2)	Higher (3)	Elementary (4)	Secondary (5)	Higher (6)	Total (4+5+6) (7)	Elementary (1x4÷7) (8)	Secondary (2x5÷7) (9)	Higher (3x6÷7) (10)
1946	200	1,072	2,670	8.0	1.3	.35	9.7	1,600	1,442	924
1947	205	1,098	2,600	8.0	1.4	.35	9.7	1,637	1,528	909
1948	210	1,129	2,590	8.0	1.4	.37	9.8	1,671	1,597	956
1949	226	1,172	2,670	8.0	1.4	.39	9.8	1,800	1,681	1,049
1950	245	1,256	2,844	7.9	1.5	.41	9.8	1,943	1,831	1,172
1951	247	1,300	2,982	7.9	1.5	.44	9.8	1,961	1,920	1,300
1952	256	1,345	3,162	7.9	1.5	.46	9.9	2,022	2,001	1,445
1953	277	1,418	3,266	7.9	1.5	.46	9.9	2,196	2,135	1,492
1954	306	1,436	3,223	7.9	1.5	.46	9.9	2,420	2,180	1,489
1955	298	1,427	3,310	7.9	1.5	.46	9.9	2,362	2,186	1,523
1956	318	1,459	3,466	7.9	1.5	.46	9.9	2,522	2,254	1,612
1957	333	1,468	3,470	7.9	1.6	.46	10.0	2,639	2,295	1,613
1958	348	1,452	3,461	7.9	1.6	.49	10.0	2,755	2,301	1,682
1959	361	1,510	3,572	7.9	1.6	.50	10.0	2,860	2,429	1,800
1960	375	1,515	3,626	7.9	1.6	.52	10.1	2,970	2,458	1,893
1961	394	1,512	3,661	7.9	1.6	.54	10.1	3,116	2,473	1,977
1962	415	1,553	3,792	7.9	1.7	.56	10.1	3,284	2,565	2,128
1963	441	1,535	3,767	7.9	1.7	.56	10.2	3,487	2,587	2,124
1964	471	1,631	3,946	7.9	1.7	.56	10.2	3,726	2,810	2,226
1965	517	1,702	4,075	7.9	1.7	.57	10.2	4,084	2,906	2,339
1966	558	1,759	4,180	7.9	1.8	.60	10.3	4,413	3,120	2,487
1967	599	1,800	4,257	7.9	1.8	.62	10.3	4,729	3,181	2,657
1968	620	1,825	4,372	7.9	1.8	.65	10.4	4,930	3,249	2,828
1969	670	1,885	4,472	7.9	1.8	.66	10.4	5,328	3,415	2,938
1970	714	1,892	4,545	7.9	1.8	.68	10.4	5,672	3,448	3,086
1971	762	1,897	4,615	8.0	1.8	.70	10.5	6,063	3,490	3,207
1972	841	1,952	4,824	8.0	1.9	.71	10.5	6,691	3,626	3,430
1973	914	1,992	5,007	8.0	1.9	.73	10.6	7,277	3,734	3,640
1974	989	2,001	5,166	8.0	1.9	.74	10.6	7,871	3,786	3,839
1975	1,069	2,040	5,414	8.0	1.9	.76	10.6	8,516	3,896	4,109

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*Totals from Table B-2, Columns 1, 5, and 9 divided by the number of students at each level.

These costs were then divided by the respective enrollment levels. Sources are: U.S.O.E., Biennial Survey of Education in the U.S., ch. 1, p. 24 and later issues, and U.S.O.E., National Center for Educational Statistics, Projections of Educational Statistics To 1979-80, 1970 Edition, 1971, p. 20. The resulting annual real costs per student are shown in Columns 1-3 in Table B-3. These costs per student were then multiplied by the average number of school years completed by the population at each level of education, shown in Columns 4-6 in Table B-3 from U.S. Bureau of the Census, Current Population Reports, Series P-20, No. 6, and later reports, and U.S. Bureau of the Census, Statistical Abstract of the U.S., 1956, p. 111 and later issues. The resulting costs per person at each level were summed and then divided by the overall average number of school years completed shown in Column 7 of Table B-3 to estimate the average annual real cost of education inclusive of all levels shown in Columns 8-10 of Table B-3, in T. W. Schultz (1971), p. 127, Table 8.3 (1957 labor force only), and Table B-1.

The resulting average cost of education for one year shown in Table B-1, Column 4, was then multiplied by the total number of constant school years completed by the population (14 years old and over) shown in Table B-1, Column 5 to estimate the total real value of the stock of educational capital, S_{ETt} which is the desired result shown in Table B-1. The following procedure was used to adjust the length of the school year to a constant 1940 base. First, the population was divided into 6 age groups (14-24, 25-34, 35-44, 45-54, 55-64, 65 years and over). The median number of school years attained by each age group as reported in U.S. Bureau of the Census, Current Population Reports, Series P-20, No. 6, and later issues, and U.S. Bureau of the Census, Statistical Abstract of the U.S., 1956, p. 111 and later editions, was then multiplied by an index measuring the length of the school year in which one-half of their education was completed, taken from U.S. Bureau of the Census, Historical Statistics of the U.S., Colonial Times To 1957, p. 207 and U.S. Bureau of the Census, Statistical Abstract of the U.S., 1962, p. 121 and later issues. Next, the constant median number of school years completed by each age group was multiplied by the total number of persons in each group, figures taken from U.S. Bureau of the Census, Current Population Reports, Series P-25, No. 311, and later issues. These results were then summed to obtain the total number of constant school years completed by the entire population aged 14 years and over.

Constant school years completed were computed for 1928-72, but all of the necessary cost data is not available for the prewar years. The values of the educational capital stock for 1928-45 therefore were obtained by interpolating between Schultz's benchmark years from T. W. Schultz (1971), p. 129, Table 8.5, Col. 3 and then adjusted for level by the ratio at the 1946 link year.

II. ESTIMATES OF THE STOCK OF HIGHER EDUCATIONAL CAPITAL

Because this study is limited to the investment demand for higher education, it is the stock of educational capital created by higher education only that is most directly relevant to the adjustment of existing stocks of educational capital in the society. New estimates of these, eliminating stocks created by primary and secondary education, are presented in the second and last columns of Table B-4 for the prewar and postwar years respectively.

For the postwar years, the total number of years of higher education completed by the population 14 years old and over shown in Column 8 of Table B-4 was estimated by multiplying the number of persons 14 years old

Table B-4. Stock of Higher Educational Capital, 1929-79 At Original Cost
(in billions of constant (1958) dollars)

Prewar years (1)	Higher educational capital S_{Et} (2)	Postwar years (3)	Persons age 14+ with 1-3 yrs. college (millions) (4)	Years completed by 1-3 yr. persons (millions) (5)	Persons age 14+ with 4 yrs. college (millions) (6)	Years completed by 4 yr. persons (millions) (7)	Total yrs. of H.Ed. Completed by population (millions) (8)	Annual cost of H.Ed. per student (in dollars) (from B-3) (9)	Higher educational capital S_{Et} (10)
1928	45.50	1946	6.7	13.4	4.7	18.8	32.2	2,670	85.97
1929	47.19	1947	7.0	14.0	4.8	19.2	33.2	2,600	86.32
1930	48.64	1948	7.4	14.8	5.2	20.8	35.6	2,590	92.20
1931	50.82	1949	7.6	15.2	5.6	22.4	37.6	2,670	100.39
1932	52.76	1950	8.0	16.0	6.1	24.4	40.4	2,844	114.90
1933	54.69	1951	8.4	16.8	6.6	26.4	43.2	2,982	128.82
1934	56.87	1952	8.8	17.6	7.1	28.4	46.0	3,162	145.45
1935	58.81	1953	8.9	17.8	7.1	28.4	46.2	3,266	150.89
1936	60.74	1954	9.0	18.0	7.3	29.2	47.2	3,223	152.12
1937	62.92	1955	9.0	18.0	7.4	29.6	47.6	3,310	157.56
1938	64.86	1956	9.1	18.2	7.6	30.4	48.6	3,466	168.45
1939	66.79	1957	9.2	18.4	7.7	30.8	49.2	3,470	170.72
1940	68.97	1958	9.7	19.4	8.2	32.8	52.2	3,461	180.66
1941	71.63	1959	10.3	20.6	8.6	34.4	55.0	3,572	196.46
1942	74.54	1960	10.9	21.8	8.9	35.6	57.4	3,626	208.13
1943	77.44	1961	11.7	23.4	9.3	37.2	60.6	3,661	221.86
1944	80.10	1962	12.3	24.6	9.9	39.6	64.2	3,792	243.45
1945	83.01	1963	12.3	24.6	10.2	40.8	65.4	3,767	246.36
		1964	12.5	25.0	10.3	41.2	66.2	3,946	261.22
		1965	12.7	25.4	10.8	43.2	68.6	4,075	279.54
		1966	13.4	26.8	11.4	45.6	72.4	4,180	302.63
		1967	14.4	28.8	11.9	47.6	76.4	4,257	325.23
		1968	15.4	30.8	12.6	50.4	81.2	4,372	363.12
		1969	15.7	31.4	13.2	52.8	84.2	4,472	376.54
		1970	16.8	33.6	13.7	54.8	88.4	4,545	401.78
		1971	17.6	35.2	14.3	57.2	92.4	4,615	426.43
		1972	18.4	36.8	14.8	59.2	96.0	4,824	463.10
		1973	19.2	38.4	15.4	61.6	100.0	5,007	500.70
		1974	20.7	41.4	15.9	63.6	105.0	5,166	542.43
		1975	20.7	41.4	16.5	66.0	107.4	5,414	581.46
		1976	21.5	43.0	17.1	68.4	111.4	5,588	622.50
		1977	22.3	44.6	17.6	70.4	115.0	5,762	662.63
		1978	23.1	46.2	18.2	72.8	119.0	5,936	706.38
		1979	23.9	47.8	18.7	74.8	122.6	6,110	749.09

and older who had completed 1-3 years in Column 4 by an average of 2 years completed by this group to get Column 5. Then the number completing at least 4 years of college in Column 6 was multiplied by 4, a conservative average of the number of years they completed, to obtain Column 7 which was added to Column 3 to get the total in Column 8. These population statistics were obtained from the Bureau of the Census Current Population Reports Series P-25, Numbers 21, 43, and 385 and Series P-20, Numbers 6, 15, 79, 121, 138, 158, 169, 182, 194, 207, and 229.

To obtain the stock of higher educational capital the total number of years of higher education completed in Column 8 was multiplied by the average annual cost per student of higher education in constant 1958 dollars shown in Column 9 and taken from Table B-3, Column 3.

For the prewar years, since the computation just described is not possible, an estimate was made by multiplying the total stock of educational capital as given by Table B-1 by .242, the link percentage in the overlapping 1946 year. This will somewhat overestimate the stock of higher educational capital in the earlier years, where its size relative to that of the primary and secondary educational capital stock is likely to be smaller than it was in 1946. The 1973-1979 projections are not based on analysis of causal influences but instead exhibit extrapolations of underlying trends.

The estimates in Table B-4 also assume that the college school year has not changed significantly over time.

Appendix C

Annual Data on Federal Investment in University-based Research 1928-68

This Appendix presents newly developed estimates of Federal investment in research done at institutions of higher education. Previously only scattered figures have been available on research done outside of industry, mostly in publications of the U.S. Office of Education and of the National Science Foundation. But considerable additional attention was needed to get these collected into one place and put on as consistent a basis as possible for the entire time period.

Estimates are shown in Table C-1, Columns 2 and 6, for Federal support research at institutions or higher education for the academic years 1928 through 1968, the last year available from U.S.O.E. publications at the time of writing. Academic year data are dated in Table C-1 as of the first half of each academic year. Federally supported research at public and private institutions in the post-war years is shown separately in Columns 7 and 11. These in turn are broken down by research at universities, 4-year colleges, and 2-year junior colleges in Columns 8-10 and 12-14. The sources for 1943-68 are as follows: U.S. Office of Education, Biennial Survey of Education, Chap. IV, "Statistics of Higher Education," 1943--Table 3, p. 42; 1945--Table 3, p. 48; 1947--Table 3, p. 58; 1949--Table 2, p. 36; 1951--Table 2, p. 48; 1953--Table 3, p. 10; 1955--Table 3, p. 10; 1957--Table 3, p. 8; U.S.O.E. Financial Statistics on Institutions of Higher Education, 1959--Table 3, p. 12; U.S.O.E., Higher Education Finances, 1961--Table 2, p. 34; ibid., 1963--Table 2, p. 4; National Center for Educational Statistics, Financial

Table 1. Federal Investment in Research at Institutions of Higher Education 1928-1968
(in millions of current dollars)

Prewar Years (1)	Total Public (2)	Postwar Years (5)	Total (6)	Public Institutions: All Public (7)	Public Institutions: Univ. (8)	Public Institutions: 4-Year (9)	Public Institutions: 2-Year (10)	Private Institutions: All Private (11)	Private Institutions: Univ. (12)	Private Institutions: 4-Year (13)	Private Institutions: 2-Year (14)
1928	3.6	1943	47.0	22.2	21.3	0.9	0	24.8	15.4	9.4	0
1929	4.6	1944	56.8	24.6	23.6	1.0	0	32.2	20.0	12.2	0
1930	4.8	1945	67.0	27.3	26.1	1.1	0	39.7	24.6	15.1	0
1931	4.2	1946	92.1	39.5	37.9	1.6	0	52.0	32.6	20.0	0
1932	4.1	1947	118.9	53.4	51.2	2.2	0	65.5	40.6	24.9	0
1933	4.1	1948	143.1	63.5	60.7	2.6	0.1	79.6	49.4	30.2	0
1934	4.2	1949	167.8	74.0	70.8	3.1	0.1	93.8	58.2	35.6	0
1935	5.4	1950	200.5	89.0	85.2	3.7	0.1	111.5	69.2	42.3	0
1936	5.8	1951	232.5	103.4	99.0	4.3	0.1	129.1	80.1	49.0	0
1937	6.0	1952	263.7	114.8	109.6	5.1	0.1	148.9	94.5	54.3	0
1938	6.1	1953	295.5	127.0	121.1	5.9	0	168.5	109.0	59.5	0
1939	6.1	1954	337.2	150.1	144.8	5.3	0	187.1	119.7	67.3	0.1
1940	6.2	1955	379.1	173.4	168.5	4.8	0	205.7	130.4	75.1	0.2
1941	6.2	1956	471.0	217.4	211.5	6.0	0	253.6	157.1	96.1	0.3
		1957	563.2	261.6	254.5	7.1	0	301.6	184.0	117.2	0.5
		1958	710.7	326.9	316.6	10.3	0	383.8	245.0	138.3	0.6
		1959	858.4	392.3	378.8	13.5	0	466.1	306.0	159.4	0.7
		1960	1083.1	486.5	467.5	19.0	0	596.6	370.6	225.2	0.8
		1961	1307.6	580.6	556.2	24.4	0	727.0	435.2	291.0	0.8
		1962	1571.3	686.1	656.7	29.3	0	885.2	512.0	372.0	1.3
		1963	1835.0	791.5	757.2	34.3	0	1043.5	588.7	453.1	1.7
		1964	1969.3	869.7	823.0	46.3	0.3	1099.6	637.0	461.0	1.6
		1965	2103.7	947.8	888.8	58.4	0.6	1155.9	685.4	469.0	1.6
		1966	2510.4	1217.7	1114.5	94.8	8.4	1292.7	875.6	415.0	2.1
		1967	2917.4	1487.8	1340.3	131.3	16.2	1429.6	1065.8	361.1	2.7
		1968	2774.9	1480.2	1317.2	137.5	25.5	1294.7	1005.8	285.1	3.8

Statistics for Institutions of Higher Education, 1965--Table 2, p. 11; ibid., 1966--Table 3, p. 14; ibid., 1967--Table 3, pp. 12-13, and ibid., 1968--Table 3.

Before 1951 total Federal research expenditures were used from these sources for two categories only, funds for public institutions and funds for private institutions, because the definitions classifying universities and 4-year colleges changed in 1951. Starting in 1951, the data are the same as those given by these publications for the following categories: (1) public universities, (2) public 4-year colleges, (3) public 2-year junior colleges, (4) private universities, (5) private 4-year colleges, and (6) private 2-year junior colleges. In order to allocate the funds granted to public and private institutions between 1943 and 1951 to the types of institutions mentioned above, percentages based on 1951 definitions were used. For example, the percentage that each type of institution represented in the total public research figure in 1951 was calculated, and these percentages were applied to the total for public institutions for the period 1943-50. Prior to 1966, the Biennial Survey of Education gives figures on Federal support for research only for every other year; the estimates for the years between biennial surveys were interpolated.

Finally, in the post World War II years Federal funds for research at institutions of higher education as described above did not include that portion of Land Grant Act funds used for research at agricultural experiment stations. The latter therefore was obtained separately from the U.S.O.E. Digest of Educational Statistics, 1963, Chapter 2, p. 83, Table 80 and later issues. Most of these funds (96.3%) went to public universities. However, the 1956-8 issue of the Biennial Survey (Ch.4,Sec.2,Table 14, p. 27) is the basis for a percentage breakdown among public institutions (Columns 7-10) which then was used for allocating total land grant act research funds among types of public institutions in the postwar years.

Although U.S.O.E. data are probably the best, if not the only, source of R & D expenditures by colleges and universities prior to 1951, there is no Biennial Survey data on research at colleges and universities for the years prior to W.W. II. Federal research support to institutions of higher education pre-war however was relatively small and was limited mainly to the research activities of state agricultural experiment stations. The data shown for 1928-41 therefore were drawn from the U.S.O.E. Bulletin No. 28, Land-Grant Colleges and Universities, 1930, p. 56, Table 13, and later issues, and applied to Federal research funds provided under the Land Grant Acts. These went to the 69 land grant institutions, 68 of which are public, plus Cornell University where the New York state college of agriculture is located. The pre-war totals in Column 2 therefore are totals for Land Grant Act research at public institutions.

For the 1928-41 period, the land grant acts were the Hatch, Adams, Purnell, Jones-Bankhead (1936), and Agricultural Adjustment Acts. For the two academic years beginning in 1929 and 1930, total Federal expenditures for institutions of higher education had to be divided between research and non-research by using the 1928 and 1931 research percentages (28.4 percent and 27.1 percent respectively). Jones-Bankhead Act Federal expenditures on higher education had to be separated into research and non-research for 1935-41 by application of the 1946 percentage (16.85), the year the relevant breakdown first became available. Funds from the other Land Grant Acts were added to the Jones-Bankhead research funds to obtain the total.

Historical Statistics of the United States, Chapter W, "Research and Development, General Note," pp. 609-14 has a good survey of related data sources. As indicated there, the oldest known current series on research expenditures is that on organized research by institutions of higher education, 1930-42 in U.S.O.E. Statistics of Higher Education: Receipts, Expenditures, and Property 1953-4, 1957, p. 131, but this reveals nothing about Federal support in relation to that from foundations, endowment funds, and state government. Joseph H. Schuster, Study Director at the National Science Foundation, who has been very helpful in developing the data presented here, also recommends U.S.O.E. over the National Science Foundation as about the only source for the years prior to 1953.